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(54) IMIDAZO [1,5-A] PYRIDINE DERIVATIVES AS INHIBITORS OF GLUTAMINYL CYCLASE

IMIDAZO[1,5-A]PYRIDINDERIVATE ALS INHIBITOREN VON GLUTAMINYLCYCLASE

DÉRIVÉS D'IMIDAZO [1,5-A] PYRIDINE COMME INHIBITEURS DE LA GLUTAMINYL CYCLASE

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- **FOS EMPAR ET AL: "Synthesis of a new 1,4-dihydropyridine containing the imidazo[1,5- a] pyridine nucleus" JOURNAL OF HETEROCYCLIC CHEMISTRY, HETEROCORPORATION. PROVO, vol. 30, no. 2, 1 March 1993 (1993-03-01), pages 473-476, XP008092507 ISSN: 0022-152X**

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Description

Field of the invention

[0001] The invention relates to novel inhibitors of glutaminyl cyclase (QC, EC 2.3.2.5). QC catalyzes the intramolecular cyclization of N-terminal glutamine residues into pyroglutamic acid (5-oxo-prolyl, pGlu*) under liberation of ammonia and the intramolecular cyclization of N-terminal glutamate residues into pyroglutamic acid under liberation of water.

Background of the invention

[0002] Glutaminyl cyclase (QC, EC 2.3.2.5) catalyzes the intramolecular cyclization of N-terminal glutamine residues into pyroglutamic acid (pGlu*) liberating ammonia. A QC was first isolated by Messer from the latex of the tropical plant *Carica papaya* in 1963 (Messer, M. 1963 Nature 4874, 1299). 24 years later, a corresponding enzymatic activity was discovered in animal pituitary (Busby, W. H. J. et al. 1987 J Biol Chem 262, 8532-8536; Fischer, W. H. and Spiess, J. 1987 Proc Natl Acad Sci U S A 84, 3628-3632). For the mammalian QC, the conversion of Gln into pGlu by QC could be shown for the precursors of TRH and GnRH (Busby, W. H. J. et al. 1987 J Biol Chem 262, 8532-8536; Fischer, W. H. and Spiess, J. 1987 Proc Natl Acad Sci U S A 84, 3628-3632). In addition, initial localization experiments of QC revealed a co-localization with its putative products of catalysis in bovine pituitary, further improving the suggested function in peptide hormone synthesis (Bockers, T. M. et al. 1995 J Neuroendocrinol 7, 445-453). In contrast, the physiological function of the plant QC is less clear. In the case of the enzyme from *C. papaya*, a role in the plant defense against pathogenic microorganisms was suggested (El Moussaoui, A. et al.2001 Cell Mol Life Sci 58, 556-570). Putative QCs from other plants were identified by sequence comparisons recently (Dahl, S. W. et al.2000 Protein Expr Purif 20, 27-36). The physiological function of these enzymes, however, is still ambiguous.

[0003] The QCs known from plants and animals show a strict specificity for L-Glutamine in the N-terminal position of the substrates and their kinetic behavior was found to obey the Michaelis-Menten equation (Pohl, T. et al. 1991 Proc Natl Acad Sci U S A 88, 10059-10063; Consalvo, A. P. et al. 1988 Anal Biochem 175, 131-138; Gololobov, M. Y. et al. 1996 Biol Chem Hoppe Seyler 377, 395-398). A comparison of the primary structures of the QCs from *C. papaya* and that of the highly conserved QC from mammals, however, did not reveal any sequence homology (Dahl, S. W. et al. 2000 Protein Expr Purif 20, 27-36). Whereas the plant QCs appear to belong to a new enzyme family (Dahl, S. W. et al. 2000 Protein Expr Purif 20, 27-36), the mammalian QCs were found to have a pronounced sequence homology to bacterial aminopeptidases (Bateman, R. C. et al. 2001 Biochemistry 40, 11246-11250), leading to the conclusion that the QCs from plants and animals have different evolutionary origins.

[0004] Recently, it was shown that recombinant human QC as well as QC-activity from brain extracts catalyze both, the N-terminal glutaminyl as well as glutamate cyclization. Most striking is the finding, that cyclase-catalyzed Glu_1-conversion is favored around pH 6.0 while Gln_1-conversion to pGlu-derivatives occurs with a pH-optimum of around 8.0. Since the formation of pGlu-Aβ-related peptides can be suppressed by inhibition of recombinant human QC and QC-activity from pig pituitary extracts, the enzyme QC is a target in drug development for treatment of Alzheimers disease.

[0005] First inhibitors of QC are described in WO 2004/098625, WO 2004/098591, WO 2005/039548 and WO 2005/075436.

[0006] EP 02 011 349.4 discloses polynucleotides encoding insect glutaminyl cyclase, as well as polypeptides encoded thereby and their use in methods of screening for agents that reduce glutaminyl cyclase activity. Such agents are useful as pesticides.

[0007] Fos Empar et al (1993) Journal of Heterocyclic Chemistry 30(2), 473-476 describes the synthesis of a new 1,4-dihydropyridine containing the imidazo [1,5-a] pyridine nucleus.

Definitions

[0008] The terms "k_i" or "K_I and "K_D" are binding constants, which describe the binding of an inhibitor to and the subsequent release from an enzyme. Another measure is the "IC_{50}" value, which reflects the inhibitor concentration, which at a given substrate concentration results in 50 % enzyme activity.

[0009] The term "DP IV-inhibitor" or "dipeptidyl peptidase IV inhibitor" is generally known to a person skilled in the art and means enzyme inhibitors, which inhibit the catalytic activity of DP IV or DP IV-like enzymes.

[0010] "DP IV-activity" is defined as the catalytic activity of dipeptidyl peptidase IV (DP IV) and DP IV-like enzymes. These enzymes are post-proline (to a lesser extent post-alanine, post-serine or post-glycine) cleaving serine proteases found in various tissues of the body of a mammal including kidney, liver, and intestine, where they remove dipeptides from the N-terminus of biologically active peptides with a high specificity when proline or alanine form the residues that are adjacent to the N-terminal amino acid in their sequence.

[0011] The term "PEP-inhibitor" or "prolyl endopeptidase inhibitor" is generally known to a person skilled in the art

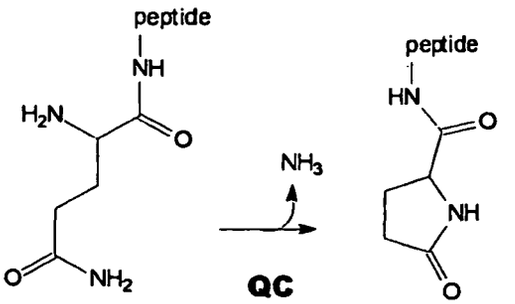
and means enzyme inhibitors, which inhibit the catalytic activity of prolyl endopeptidase (PEP, prolyl oligopeptidase, POP).

[0012] "PEP-activity" is defined as the catalytic activity of an endoprotease that is capable to hydrolyze post proline bonds in peptides or proteins were the proline is in amino acid position 3 or higher counted from the N-terminus of a peptide or protein substrate.

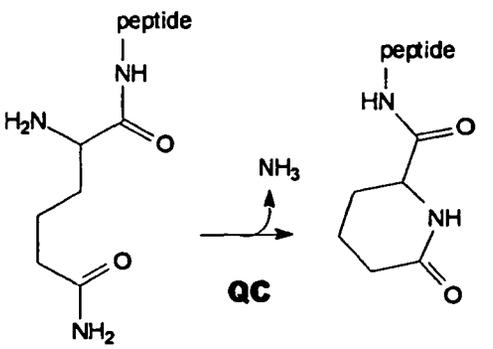
[0013] The term "QC" as used herein comprises glutaminyl cyclase (QC) and QC-like enzymes. QC and QC-like enzymes have identical or similar enzymatic activity, further defined as QC activity. In this regard, QC-like enzymes can fundamentally differ in their molecular structure from QC. Examples of QC-like enzymes are the glutaminyl-peptide cyclotransferase-like proteins (QPCTLs) from human (GenBank NM_017659), mouse (GenBank BC058181), Macaca fascicularis (GenBank AB168255), Macaca mulatta (GenBank XM_001110995), Canis familiaris (GenBank XM_541552), Rattus norvegicus (GenBank XM_001066591), Mus musculus (GenBank BC058181) and Bos taurus (GenBank BT026254).

[0014] The term "QC activity" as used herein is defined as intramolecular cyclization of N-terminal glutamine residues into pyroglutamic acid (pGlu*) or of N-terminal L-homoglutamine or L-β-homoglutamine to a cyclic pyro-homoglutamine derivative under liberation of ammonia. See therefore schemes 1 and 2.

Scheme 1: Cyclization of glutamine by QC



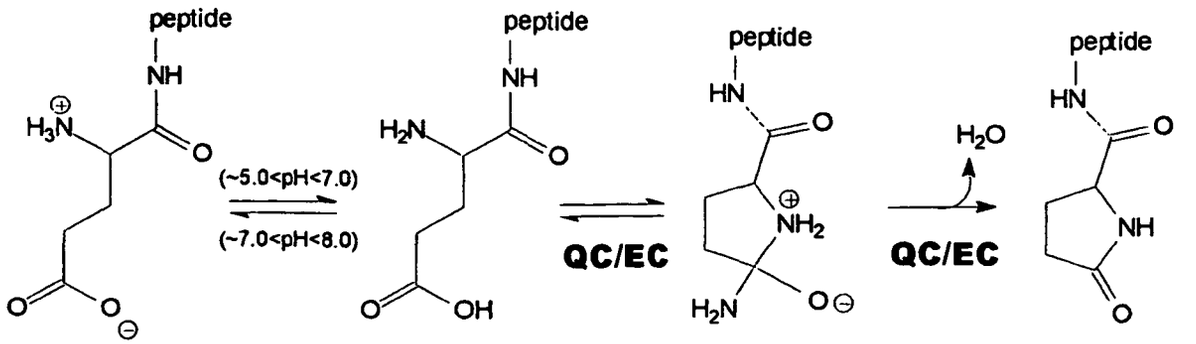
Scheme 2: Cyclization of L-homoglutamine by QC



[0015] The term "EC" as used herein comprises the activity of QC and QC-like enzymes as glutamate cyclase (EC), further defined as EC activity.

[0016] The term "EC activity" as used herein is defined as intramolecular cyclization of N-terminal glutamate residues into pyroglutamic acid (pGlu*) by QC. See therefore scheme 3.

Scheme 3: N-terminal cyclization of uncharged glutamyl peptides by QC (EC)



[0017] The term "QC-inhibitor" "glutaminyl cyclase inhibitor" is generally known to a person skilled in the art and means enzyme inhibitors, which inhibit the catalytic activity of glutaminyl cyclase (QC) or its glutamyl cyclase (EC) activity.

Potency of QC inhibition

[0018] In light of the correlation with QC inhibition, in preferred embodiments, the subject method and medical use utilize an agent with an IC_{50} for QC inhibition of 10 μM or less, more preferably of 1 μM or less, even more preferably of 0.1 μM or less or 0.01 μM or less, or most preferably 0.001 μM or less. Indeed, inhibitors with K_i values in the lower micromolar, preferably the nanomolar and even more preferably the picomolar range are contemplated. Thus, while the active agents are described herein, for convenience, as "QC inhibitors", it will be understood that such nomenclature is not intending to limit the subject of the invention to a particular mechanism of action.

Molecular weight of QC inhibitors

[0019] In general, the QC inhibitors of the subject method or medical use will be small molecules, e.g., with molecular weights of 500 g/mole or less, 400 g/mole or less, preferably of 350 g/mole or less, and even more preferably of 300 g/mole or less and even of 250 g/mole or less.

[0020] The term "subject" as used herein, refers to an animal, preferably a mammal, most preferably a human, who has been the object of treatment, observation or experiment.

[0021] The term "therapeutically effective amount" as used herein, means that amount of active compound or pharmaceutical agent that elicits the biological or medicinal response in a tissue system, animal or human being sought by a researcher, veterinarian, medical doctor or other clinician, which includes alleviation of the symptoms of the disease or disorder being treated.

[0022] As used herein, the term "pharmaceutically acceptable" embraces both human and veterinary use: For example the term "pharmaceutically acceptable" embraces a veterinarily acceptable compound or a compound acceptable in human medicine and health care.

[0023] Throughout the description and the claims the expression "alkyl", unless specifically limited, denotes a C_{1-8} alkyl group, suitably a C_{1-6} alkyl group, e.g. C_{1-4} alkyl group. Alkyl groups may be straight chain or branched. Suitable alkyl groups include, for example, methyl, ethyl, propyl (e.g. n-propyl and isopropyl), butyl (e.g n-butyl, iso-butyl, sec-butyl and tert-butyl), pentyl (e.g. n-pentyl), hexyl (e.g. n-hexyl), heptyl (e.g. n-heptyl) and octyl (e.g. n-octyl). The expression "alk", for example in the expressions "alkoxy", "fluoroalkyl" and "thioalkyl" should be interpreted in accordance with the definition of "alkyl". Exemplary alkoxy groups include methoxy, ethoxy, propoxy (e.g. n-propoxy), butoxy (e.g. n-butoxy), pentoxy (e.g. n-pentoxy), hexoxy (e.g. n-hexoxy), heptoxy (e.g. n-heptoxy) and octoxy (e.g. n-octoxy). Exemplary thioalkyl groups include methylthio-. Exemplary fluoroalkyl groups include CF_3.

[0024] The term "alkenyl" may be interpreted similarly to the expression "alkyl" save that alkenyl groups will contain at least 1 (e.g. 1 or 2, particularly 1) double bond. An exemplary alkenyl group is ethenyl.

[0025] The expression "cycloalkyl", unless specifically limited, denotes a C_{3-10} cycloalkyl group (i.e. 3 to 10 ring carbon atoms), more suitably a C_{3-8} cycloalkyl group, e.g. a C_{3-8} cycloalkyl group. Exemplary cycloalkyl groups include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl and cyclooctyl. A most suitable number of ring carbon atoms is three to six.

[0026] The expression "cycloalkenyl", unless specifically limited, denotes a C_{5-10} cycloalkenyl group (i.e. 5 to 10 ring carbon atoms), more suitably a C_{5-8} cycloalkenyl group e.g. a C_{5-6} cycloalkenyl group. Exemplary cycloalkenyl groups

include cyclopropenyl, cyclohexenyl, cycloheptenyl and cyclooctenyl. A most suitable number of ring carbon atoms is five to six.

[0027] The expression "carbocyclyl", unless specifically limited, denotes any ring system in which all the ring atoms are carbon and which contains between three and ten ring carbon atoms, and more suitably between three and eight carbon atoms. Carbocyclyl groups may be saturated or partially unsaturated, but do not include aromatic rings. Examples of carbocyclyl groups include monocyclic, bicyclic, and tricyclic ring systems, in particular monocyclic and bicyclic ring systems. Other carbocyclyl groups include bridged ring systems (e.g. bicyclo[2.2.1]heptenyl). A specific example of a carbocyclyl group is a cycloalkyl group. A further example of a carbocyclyl group is a cycloalkenyl group.

[0028] The expression "heterocyclyl", unless specifically limited, refers to a carbocyclyl group wherein one or more (e.g. 1, 2 or 3) ring atoms are replaced by heteroatoms selected from N, S and O. A specific example of a heterocyclyl group is a cycloalkyl group (e.g. cyclopentyl or more particularly cyclohexyl) wherein one or more (e.g. 1, 2 or 3, particularly 1 or 2, especially 1) ring atoms are replaced by heteroatoms selected from N, S or O. Exemplary heterocyclyl groups containing one hetero atom include pyrrolidine, tetrahydrofuran and piperidine, and exemplary heterocyclyl groups containing two hetero atoms include morpholine and piperazine. A further specific example of a heterocyclyl group is a cycloalkenyl group (e.g. a cyclohexenyl group) wherein one or more (e.g. 1, 2 or 3, particularly 1 or 2, especially 1) ring atoms are replaced by heteroatoms selected from N, S and O. An example of such a group is dihydropyranyl (e.g. 3,4-dihydro-2H-pyran-2-yl-).

[0029] The expression "aryl", unless specifically limited, denotes a C_{6-12} aryl group, suitably a C_{6-10} aryl group, more suitably a C_{6-8} aryl group. Aryl groups will contain at least one aromatic ring (e.g. one or two or three rings), but may also comprise partially or fully unsaturated rings. An example of a typical aryl group with one aromatic ring is phenyl. Examples of aromatic groups with two aromatic rings include naphthyl. Examples of aryl groups which contain partially or fully unsaturated rings include pentalene, indene and indane. Typically the aryl group will be phenyl.

[0030] The expression "heteroaryl", unless specifically limited, denotes an aryl residue, wherein one or more (e.g. 1, 2, 3, or 4, suitably 1, 2 or 3) ring atoms are replaced by heteroatoms selected from N, S and O.
Exemplary bicyclic heteroaryl groups include quinoline, benzothiophene, indole (e.g. 1H-indol-6-yl), benzimidazole, indazole, purine, chromene, benzodioxolane (e.g. benzo[1,3]dioxol-5-yl), benzodioxane (e.g. 2,3-dihydro-benzo[1,4] dioxin-6-yl) and benzodioxepine.

[0031] The expression "-alkylaryl", unless specifically limited, denotes an aryl residue which is connected via an alkylene moiety e.g. a C_{1-4}alkylene moiety. Examples of -alkylaryl include - methylaryl (e.g. benzyl) and -ethylaryl.

[0032] The expression "-alkylheteroaryl", unless specifically limited, denotes a heteroaryl residue, which is connected via an alkylene moiety e.g. a C_{1-4}alkylene moiety. Examples of -alkylheteroaryl include -methylheteroaryl and -ethyl-heteroaryl (e.g. 1-heteroarylethyl- and 2-heteroarylethyl-).

[0033] The term "halogen" or "halo" comprises fluorine (F), chlorine (Cl), bromine (Br) and iodine (I), more typically F, Cl or Br.

Stereoisomers:

[0034] All possible stereoisomers of the claimed compounds are included in the present invention.

[0035] Where the compounds according to this invention have at least one chiral center, they may accordingly exist as enantiomers. Where the compounds possess two or more chiral centers, they may additionally exist as diastereomers. It is to be understood that all such isomers and mixtures thereof are encompassed within the scope of the present invention.

Preparation and isolation of stereoisomers:

[0036] Where the processes for the preparation of the compounds according to the invention give rise to a mixture of stereoisomers, these isomers may be separated by conventional techniques such as preparative chromatography. The compounds may be prepared in racemic form, or individual enantiomers may be prepared either by enantiospecific synthesis or by resolution. The compounds may, for example, be resolved into their components enantiomers by standard techniques, such as the formation of diastereomeric pairs by salt formation with an optically active acid, such as (-)-di-p-toluoyl-d-tartaric acid and/or (±)-di-p-toluoyl-l-tartaric acid followed by fractional crystallization and regeneration of the free base. The compounds may also be resolved by formation of diastereomeric esters or amides, followed by chromatographic separation and removal of the chiral auxiliary. Alternatively, the compounds may be resolved using a chiral HPLC column.

Pharmaceutically acceptable salts:

[0037] In view of the close relationship between the free compounds and the compounds in the form of their salts or

solvates, whenever a compound is referred to in this context, a corresponding salt or solvate is also intended, provided such is possible or appropriate under the circumstances.

[0038] Salts and solvates of the compounds of formula (I) and physiologically functional derivatives thereof which are suitable for use in medicine are those wherein the counter-ion or associated solvent is pharmaceutically acceptable. However, salts and solvates having non-pharmaceutically acceptable counter-ions or associated solvents are within the scope of the present invention, for example, for use as intermediates in the preparation of other compounds and their pharmaceutically acceptable salts and solvates.

[0039] Suitable salts according to the invention include those formed with both organic and inorganic acids or bases. Pharmaceutically acceptable acid addition salts include those formed from hydrochloric, hydrobromic, sulfuric, nitric, citric, tartaric, phosphoric, lactic, pyruvic, acetic, trifluoroacetic, triphenylacetic, sulfamic, sulfanilic, succinic, oxalic, fumaric, maleic, malic, mandelic, glutamic, aspartic, oxaloacetic, methanesulfonic, ethanesulfonic, arylsulfonic (for example p-toluenesulfonic, benzenesulfonic, naphthalenesulfonic or naphthalenedisulfonic), salicylic, glutaric, gluconic, tricarballylic, cinnamic, substituted cinnamic (for example, phenyl, methyl, methoxy or halo substituted cinnamic, including 4-methyl and 4-methoxycinnamic acid), ascorbic, oleic, naphthoic, hydroxynaphthoic (for example 1- or 3-hydroxy-2-naphthoic), naphthaleneacrylic (for example naphthalene-2-acrylic), benzoic, 4-methoxybenzoic, 2- or 4-hydroxybenzoic, 4-chlorobenzoic, 4-phenylbenzoic, benzeneacrylic (for example 1,4-benzenediacrylic), isethionic acids, perchloric, propionic, glycolic, hydroxyethanesulfonic, pamoic, cyclohexanesulfamic, salicylic, saccharinic and trifluoroacetic acid. Pharmaceutically acceptable base salts include ammonium salts, alkali metal salts such as those of sodium and potassium, alkaline earth metal salts such as those of calcium and magnesium and salts with organic bases such as dicyclohexylamine and *N*-methyl-D-glucamine.

All pharmaceutically acceptable acid addition salt forms of the compounds of the present invention are intended to be embraced by the scope of this invention.

Polymorph crystal forms:

[0040] Furthermore, some of the crystalline forms of the compounds may exist as polymorphs and as such are intended to be included in the present invention. In addition, some of the compounds may form solvates with water (i.e. hydrates) or common organic solvents, and such solvates are also intended to be encompassed within the scope of this invention. The compounds, including their salts, can also be obtained in the form of their hydrates, or include other solvents used for their crystallization.

Prodrugs:

[0041] The compounds of the present invention may be administered as prodrugs of the compounds of this invention. In general, such prodrugs will be functional derivatives of the compounds which are readily convertible *in vivo* into the desired therapeutically active compound. Conventional procedures for the selection and preparation of suitable prodrug derivatives are described, for example, in "Design of Prodrugs", ed. H. Bundgaard, Elsevier, 1985.

Protective Groups:

[0042] During any of the processes for preparation of the compounds of the present invention, it may be necessary and/or desirable to protect sensitive or reactive groups on any of the molecules concerned. This may be achieved by means of conventional protecting groups, such as those described in Protective Groups in Organic Chemistry, ed. J.F.W. McOmie, Plenum Press, 1973; and T.W. Greene & P.G.M. Wuts, Protective Groups in Organic Synthesis, John Wiley & Sons, 1991, fully incorporated herein by reference. The protecting groups may be removed at a convenient subsequent stage using methods known from the art.

[0043] As used herein, the term "composition" is intended to encompass a product comprising the claimed compounds in the therapeutically effective amounts, as well as any product which results, directly or indirectly, from combinations of the claimed compounds.

Carriers and Additives for galenic formulations:

[0044] Thus, for liquid oral preparations, such as for example, suspensions, elixirs and solutions, suitable carriers and additives may advantageously include water, glycols, oils, alcohols, flavoring agents, preservatives, coloring agents and the like; for solid oral preparations such as, for example, powders, capsules, gelcaps and tablets, suitable carriers and additives include starches, sugars, diluents, granulating agents, lubricants, binders, disintegrating agents and the like.

[0045] Carriers, which can be added to the mixture, include necessary and inert pharmaceutical excipients, including, but not limited to, suitable binders, suspending agents, lubricants, flavorants, sweeteners, preservatives, coatings,

disintegrating agents, dyes and coloring agents.

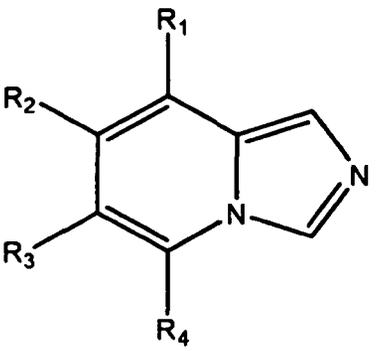
[0046] Soluble polymers as targetable drug carriers can include polyvinylpyrrolidone, pyran copolymer, polyhydroxypropylmethacrylamidephenol, polyhydroxyethylaspartamide-phenol, or polyethyleneoxidepolyllysine substituted with palmitoyl residue. Furthermore, the compounds of the present invention may be coupled to a class of biodegradable polymers useful in achieving controlled release of a drug, for example, polyactic acid, polyepsilon caprolactone, polyhydroxy butyeric acid, polyorthoesters, polyacetals, polydihydropyrans, polycyanoacrylates and crosslinked or amphipathic block copolymers of hydrogels.

[0047] Suitable binders include, without limitation, starch, gelatin, natural sugars such as glucose or betalactose, corn sweeteners, natural and synthetic gums such as acacia, tragacanth or sodium oleate, sodium stearate, magnesium stearate, sodium benzoate, sodium acetate, sodium chloride and the like.

[0048] Disintegrators include, without limitation, starch, methyl cellulose, agar, bentonite, xanthan gum and the like.

Summary of the invention

[0049] According to the invention there are provided compounds of formula (I),



(I)

or a pharmaceutically acceptable salt or solvate thereof, including all tautomers, stereoisomers and polymorphs thereof wherein:

R^1 represents C_{2-8}alkyl; C_{2-8}alkenyl; -(C_{1-6}alkyl)-C_{6-12}aryl; -(C_{1-6}alkyl)-bicyclic heteroaryl; -C_{6-12}aryl; or -bicyclic heteroaryl;
wherein said -C_{6-12}aryl or -bicyclic heteroaryl groups may be optionally substituted by one or more substituents selected from halogen, C_{1-4}alkyl, C_{1-4}fluoroalkyl, C_{1-4}alkoxy, C_{1-4}fluoroalkoxy, hydroxy, -SO_2(C_{1-4}alkyl), -SO_2N(C_{1-4}alkyl)(C_{1-4}alkyl), -SOC_{1-4}alkyl, -SOC_{3-6}cycloalkyl, -C(O)O(C_{1-4}alkyl), benzyloxy and phenyl;
R^2 represents H;
R^3 represents H; and
R^4 represents H;
wherein -bicyclic heteroaryl denotes a -bicyclic C_{6-12}aryl residue, wherein one or more ring atoms are replaced by heteroatoms selected from N, S and O.

Detailed description of the invention

[0050] The C_{6-12}aryl or -bicyclic heteroaryl groups within the definition R^1 may optionally bear one or more substituents e.g. 1, 2 or 3 substituents e.g. 1 or 2 substituents. Substituents are selected from halogen (including fluoro, chloro, bromo), C_{1-4}alkyl (e.g. methyl), C_{1-4}fluoroalkyl (e.g. trifluoromethyl), C_{1-4}alkoxy (such as methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, t-butoxy), C_{1-4}fluoroalkoxy (such as trifluoromethoxy), hydroxy, -SO_2(C_{1-4}alkyl) (such as -SO_2Me), -SO_2N(C_{1-4}alkyl)(C_{1-4}alkyl) (such as -SO_2NMe_2), -C(O)O(C_{1-4}alkyl) (such as -C(O)OMe), benzyloxy and phenyl; e.g. selected from halogen, C_{1-4}alkyl, C_{1-4}fluoroalkyl, C_{1-4}alkoxy. Further suitable examples are, -SOC_{1-4}alkyl (e.g. SOMe) and -SOC_{3-6}cycloalkyl (eg -SO-cyclopropyl).

[0051] When R^1 represents C_{2-8}alkyl, examples include ethyl, propyl (e.g. n-propyl, iso-propyl), butyl (e.g. n-butyl, iso-butyl, sec-butyl, tert-butyl), pentyl, hexyl, heptyl and octyl, particularly C_{4-8}alkyl such as isobutyl or n-butyl.

[0052] When R^1 represents optionally substituted C_{6-12}aryl, examples include optionally substituted phenyl such as phenyl, 2-fluoro-phenyl-, 3-fluoro-phenyl-, 4-fluoro-phenyl-, 2-chloro-phenyl-, 3-chloro-phenyl-, 4-chloro-phenyl-, 2-trif-

luoromethyl-phenyl-, 2-methoxy-phenyl-, 3-methoxy-phenyl-, 4-methoxy-phenyl-, 2-benzyloxy-phenyl-, 3-benzyloxy-phenyl-, 4-benzyloxy-phenyl-, 2-phenyl-phenyl-, 3-phenyl-phenyl-, 4-phenyl-phenyl-, 2-trifluoromethoxy-phenyl-, 4-ethoxy-phenyl-, 4-methoxy-3-methyl-phenyl-, 3,4-dimethoxy-phenyl- and 4-methoxy-3,5-dimethylphenyl-.

[0053] When R^1 represents -C_{1-6}alkyl-C_{6-12}aryl in which C_{6-12}aryl may be optionally substituted, examples include -methyl-phenyl (i.e. benzyl), -methyl-tolyl, -ethyl-phenyl, especially benzyl.

[0054] When R^1 represents optionally substituted -bicyclic heteroaryl, examples include benzo[1,3]dioxol-5-yl and 2,3-dihydro-benzo[1,4]dioxin-6-yl.

[0055] In one embodiment, when R^2, R^3 and R^4 are H then R^1 is not C_{2-5}alkyl.

[0056] Suitably, R^1 represents C_{2-8}alkyl, -(C_{1-6}alkyl)-C_{6-12}aryl, -bicyclic heteroaryl or -C_{6-12}aryl;
wherein said -bicyclic heteroaryl or -C_{6-12}aryl groups may be optionally substituted by one or more substituents selected from halogen (including fluoro, chloro, bromo), C_{1-4}alkyl, C_{1-4}fluoroalkyl (e.g. trifluoromethyl), C_{1-4}alkoxy (such as methoxy, ethoxy, n-propoxy, i-propoxy, n-butyl, t-butyl), C_{1-4}fluoroalkoxy (e.g. trifluoromethoxy), hydroxy, -SO_2(C_{1-4}alkyl), -SO_2N(C_{1-4}alkyl)(C_{1-4}alkyl), -C(O)O(C_{1-4}alkyl), benzyloxy and phenyl.
For example R^1 represents -(C_{1-6}alkyl)-C_{6-12}aryl, -bicyclic heteroaryl or -C_{6-12}aryl;
wherein said -bicyclic heteroaryl or -C_{6-12}aryl groups may be optionally substituted by one or more substituents selected from halogen (including fluoro, chloro, bromo), C_{1-4}alkyl, C_{1-4}fluoroalkyl (e.g. trifluoromethyl), C_{1-4}alkoxy (such as methoxy, ethoxy, n-propoxy, i-propoxy, n-butyl, t-butyl), C_{1-4}fluoroalkoxy (e.g. trifluoromethoxy), hydroxy, -SO_2(C_{1-4}alkyl), -SO_2N(C_{1-4}alkyl)(C_{1-4}alkyl), -C(O)O(C_{1-4}alkyl), benzyloxy and phenyl.

[0057] More suitably R^1 represents C_{2-8}alkyl, -bicyclic heteroaryl, -C_{6-12}aryl (e.g. phenyl) or -(C_{1-4}alkyl)-C_{6-12}aryl (e.g. C_{1-4}alkyl phenyl) which -bicyclic heteroaryl or -C_{6-12}aryl group may be optionally substituted by one or more substituents selected from halogen (including fluoro, chloro, bromo), C_{1-4}alkyl (e.g. methyl), C_{1-4}fluoroalkyl (e.g. trifluoromethyl), C_{1-4}alkoxy (such as methoxy, ethoxy, n-propoxy, i-propoxy, n-butyl, t-butyl), C_{1-4}fluoroalkoxy (e.g. trifluoromethoxy), benzyloxy and phenyl.
For example R^1 represents -bicyclic heteroaryl, -C_{6-12}aryl (e.g. phenyl) or -(C_{1-4}alkyl)-C_{6-12}aryl (e.g. C_{1-4}alkyl phenyl) which -bicyclic heteroaryl or -C_{6-12}aryl group may be optionally substituted by one or more substituents selected from halogen (including fluoro, chloro, bromo), C_{1-4}alkyl (e.g. methyl), C_{1-4}fluoroalkyl (e.g. trifluoromethyl), C_{1-4}alkoxy (such as methoxy, ethoxy, n-propoxy, i-propoxy, n-butyl, t-butyl), C_{1-4}fluoroalkoxy (e.g. trifluoromethoxy), benzyloxy and phenyl.

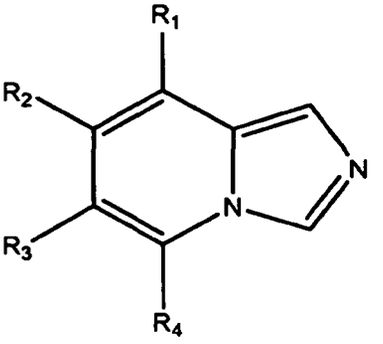
[0058] More suitably R^1 represents 4-methoxy-phenyl-, 4-chloro-phenyl-, 3-methoxy-phenyl-, 3-benzyloxy-phenyl-, phenyl, 2,3-dihydro-benzo[1,4]dioxin-4-yl, 3-fluoro-phenyl-, 4-fluoro-phenyl-, 3-phenyl-phenyl-, 2-methoxy-phenyl-, 4-ethoxy-phenyl-, 3,4-dimethoxy-phenyl-, 3-chloro-phenyl-, benzyl, n-butyl or isobutyl.
For example R^1 represents 4-methoxy-phenyl-, 4-chloro-phenyl-, 3-methoxy-phenyl-, 3-benzyloxy-phenyl-, phenyl, 2,3-dihydro-benzo[1,4]dioxin-4-yl, 3-fluoro-phenyl-, 4-fluoro-phenyl-, 3-phenyl-phenyl-, 2-methoxy-phenyl-, 4-ethoxy-phenyl-, 3,4-dimethoxy-phenyl-, 3-chloro-phenyl- or benzyl.

[0059] Most suitably R^1 represents optionally substituted (e.g. substituted) -C_{6-12}aryl (e.g. phenyl).

Processes

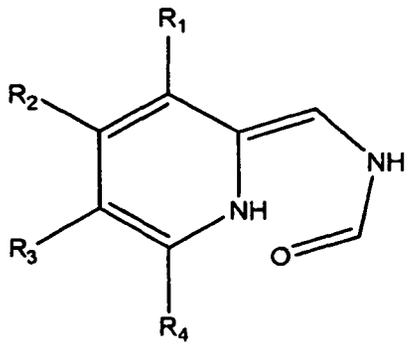
Preparation of a compound of formula (I)

[0060]



(I)

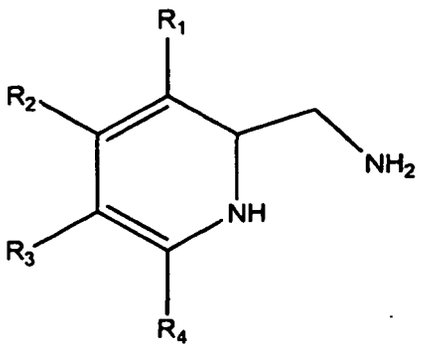
may be achieved by ring closure reaction of a compound of formula (II).



(II)

[0061] Ring closure of compounds of formula (II) may be effected by employment of a suitable reagent (e.g. $POCl_3$). The reaction may suitably be carried out in an organic solvent such as an aprotic solvent (e.g. toluene) at reflux.

[0062] A compound of formula (II) may be prepared by reaction of a compound of formula (III)

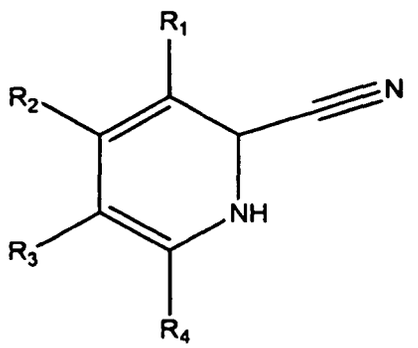


(III)

with methanoic acid or an activated derivative thereof, such as a corresponding anhydride or acyl halide (e.g. acyl chloride).

[0063] Compounds of formula (II) may be formed *in situ* i.e. the compounds of formula (II) need not be isolated from the reaction mixture before onwards reaction to compounds of formula (I).

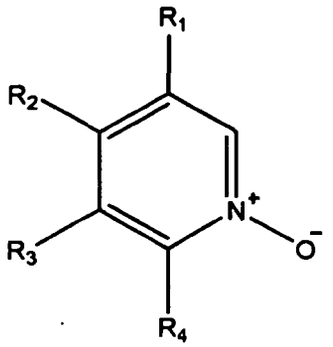
[0064] A compound of formula (III) can be prepared by reduction of a compound of formula (IV).



(IV)

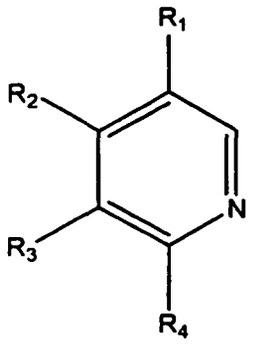
[0065] For example, the reduction may be effected by hydrogenation in the presence of a suitable catalyst or alternatively by reaction of a compound of formula (IV) with a BH_3 complex such as BH_3*THF.

[0066] A compound of formula (IV) can be prepared from a compound of formula (V). For example, the transformation may be carried out by use of dimethylcarbamoyl chloride and trimethylsilyl cyanide or by use of potassium cyanide and dimethylsulfate.



(V)

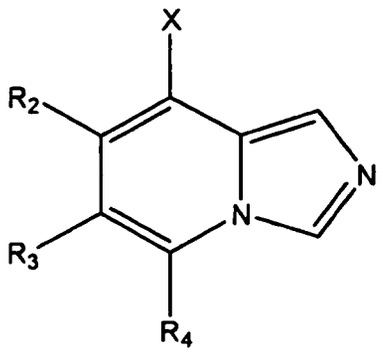
[0067] A compound of formula (V) may be prepared by reaction of a compound of formula (VI)



(VI)

with a peroxyacid, which may itself be formed *in situ* (e.g. by reaction of hydrogen peroxide with ethanoic acid) and the reaction may be carried out at elevated temperature.

[0068] Alternatively, compounds of formula (I) in which R^1 represents -C_{6-12}aryl or bicyclic heteroaryl can be prepared via a cross-coupling reaction (e.g. a Suzuki cross-coupling or a Stille coupling) by reaction of a compound of formula (VII)



(VII)

wherein X represents a substituent that is suitable for participation in a cross-coupling reaction (e.g. halogen, such as Br or I, or e.g. OTf),
with a suitable -C_{6-12}aryl or -bicyclic heteroaryl coupling partner of formula (VIII)

$$R^1\text{-}Y \qquad \text{(VIII)}$$

wherein R^1 represent -C_{8-12}aryl or -bicyclic heteroaryl and Y represents a boron or tin derivative,for example such that

R^1-Y represents an aryl boronic acid, e.g. Ar-$B(OH)_2$ or a trialkyl tin compound e.g. Ar-$Sn(alkyl)_3$.

[0069] Compounds of formula (VII) may be made in an analogous fashion to compounds of formula (I) *via* intermediates corresponding to compounds (II) to (VI) in which R^1 represents X.

[0070] Compounds of formulae (VI) and (VIII) are either known or may be prepared by conventional methods known *per* se.

[0071] If desired or necessary, compounds of formulae (II) to (VIII) may be employed in the form of protected derivatives. Protecting groups and means for removing them will be well known to a person skilled in the art (e.g. see "Protective Groups in Organic Synthesis", by Theodora W. Greene and Peter G.M. Wuts, published by John Wiley & Sons Inc; 4th Rev Ed, 2006, ISBN-10: 0471697540).

Therapeutic uses

[0072] Physiological substrates of QC (EC) in mammals are, e.g. amyloid beta-peptides (3-40), (3-42), (11-40) and (11-42), ABri, ADan, Gastrin, Neurotensin, FPP, CCL 2, CCL 7, CCL 8, CCL 16, CCL 18, Fractalkine, Orexin A, [Gln^3]-glucagon(3-29), [Gln^5]-substance P(5-11) and the peptide QYNAD. For further details see table 1. The compounds and/or combinations according to the present invention and pharmaceutical compositions comprising at least one inhibitor of QC (EC) are useful for the treatment of conditions that can be treated by modulation of QC activity.

Table 1: Amino acid sequences of physiological active peptides with an N-terminal glutamine residue, which are prone to be cyclized to final pGlu

Peptide	Amino acid sequence	Function
Abeta(1-42)	Asp-Ala-Glu-Phe-Arg-His-Asp-Ser-Gly-Tyr-Glu-Val-His-His-Gln-Lys-Leu-Val-Phe-Phe-Ala-Glu-Asp-Val-Gly-Ser-Asn-Lys-Gly-Ala-Ile-Ile-Gly-Leu-Met-Val-Gly-Gly-Val-Val-Ile-Ala	Plays a role in neurodegeneration, e.g. in Alzheimer's Disease, Familial British Dementia, Familial Danish Dementia, Down Syndrome
Abeta(1-40)	Asp-Ala-Glu-Phe-Arg-His-Asp-Ser-Gly-Tyr-Glu-Val-His-His-Gln-Lys-Leu-Val-Phe-Phe-Ala-Glu-Asp-Val-Gly-Ser-Asn-Lys-Gly-Ala-Ile-Ile-Gly-Leu-Met-Val-Gly-Gly-Val-Val	Plays a role in neurodegeneration, e.g. in Alzheimer's Disease, Familial British Dementia, Familial Danish Dementia, Down Syndrome
Abeta(3-42)	Glu-Phe-Arg-His-Asp-Ser-Gly-Tyr-Glu-Val-His-His-Gln-Lys-Leu-Val-Phe-Phe-Ala-Glu-Asp-Val-Gly-Ser-Asn-Lys-Gly-Ala-Ile-Ile-Gly-Leu-Met-Val-Gly-Gly-Val-Val-Ile-Ala	Plays a role in neurodegeneration, e.g. in Alzheimer's Disease, Familial British Dementia, Familial Danish Dementia, Down Syndrome
Abeta(3-40)	Glu-Phe-Arg-His-Asp-Ser-Gly-Tyr-Glu-Val-His-His-Gln-Lys-Leu-Val-Phe-Phe-Ala-Glu-Asp-Val-Gly-Ser-Asn-Lys-Gly-Ala-Ile-Ile-Gly-Leu-Met-Val-Gly-Gly-Val-Val	Plays a role in neurodegeneration, e.g. in Alzheimer's Disease, Familial British Dementia, Familial Danish Dementia, Down Syndrome

(continued)

Peptide	Amino acid sequence	Function
Abeta(11-42)	Glu-Val-His-His-Gln-Lys-Leu-Val-Phe-Phe-Ala-Glu-Asp-Val-Gly-Ser-Asn-Lys-Gly-Ala-Ile-Ile-Gly-Leu-Met-Val-Gly-Gly-Val-Val-Ile-Ala	Plays a role in neurodegeneration, e.g. in Alzheimer's Disease, Familial British Dementia, Familial Danish Dementia, Down Syndrome
Abeta(11-40)	Glu-Val-His-His-Gln-Lys-Leu-Val-Phe-Phe-Ala-Glu-Asp-Val-Gly-Ser-Asn-Lys-Gly-Ala-Ile-Ile-Gly-Leu-Met-Val-Gly-Gly-Val-Val	Plays a role in neurodegeneration, e.g. in Alzheimer's Disease, Familial British Dementia, Familial Danish Dementia, Down Syndrome
ABri	EASNCFA IRHFENKFAV ETLIC SRTVKKNIIEEN	Pyroglutamated form plays a role in Familial British Dementia
ADan	EASNCFA IRHFENKFAV ETLIC FNLFLNSQEKHY	Pyroglutamated form plays a role in Familial Danish Dementia
Gastrin 17 Swiss-Prot: P01350	QGPWL EEEEEAYGWM DF (amide)	Gastrin stimulates the stomach mucosa to produce and secrete hydrochloric acid and the pancreas to secrete its digestive enzymes. It also stimulates smooth muscle contraction and increases blood circulation and water secretion in the stomach and intestine.
Neurotensin Swiss-Prot: P30990	QLYENKPRRP YIL	Neurotensin plays an endocrine or paracrine role in the regulation of fat metabolism. It causes contraction of smooth muscle.
FPP	QEP amide	A tripeptide related to thyrotrophin releasing hormone (TRH), is found in seminal plasma. Recent evidence obtained *in vitro* and *in vivo* showed that FPP plays an important role in regulating sperm fertility.
TRH Swiss-Prot: P20396	QHP amide	TRH functions as a regulator of the biosynthesis of TSH in the anterior pituitary gland and as a neurotransmitter/ neuromodulator in the central and peripheral nervous systems.

(continued)

Peptide	Amino acid sequence	Function
GnRH Swiss-Prot: P01148	QHWSYGL RP(G) amide	Stimulates the secretion of gonadotropins; it stimulates the secretion of both luteinizing and follicle-stimulating hormones.
CCL16 (small inducible cytokine A16) Swiss-Prot: 015467	QPKVPEW VNTPSTCCLK YYEKVLPRRL VVGYRKALNC HLPAIIFVTK RNREVCTNPN DDWVQEYIKD PNLPLLPTRN LSTVKIITAK NGQPQLLNSQ	Shows chemotactic activity for lymphocytes and monocytes but not neutrophils. Also shows potent myelosuppressive activity, suppresses proliferation of myeloid progenitor cells. Recombinant SCYA16 shows chemotactic activity for monocytes and THP-1 monocytes, but not for resting lymphocytes and neutrophils. Induces a calcium flux in THP-1 cells that were desensitized by prior expression to RANTES.
CCL8 (small inducible cytokine A8) Swiss-Prot: P80075	QPDSVSI PITCCFNVIN RKIPIQRLES YTRITNIQCP KEAVIFKTKR GKEVCADPKE RWVRDSMKHL DQIFQNLKP	Chemotactic factor that attracts monocytes, lymphocytes, basophils and eosinophils. May play a role in neoplasia and inflammatory host responses. This protein can bind heparin.
CCL2 (MCP-1, small inducible cytokine A2) Swiss-Prot: P13500	QPDAINA PVTCCYNFTN RKISVQRLAS YRRITSSKCP KEAVIFKTIV AKEICADPKQ KWVQDSMDHL DKQTQTPKT	Chemotactic factor that attracts monocytes and basophils but not neutrophils or eosinophils. Augments monocyte anti-tumor activity. Has been implicated in the pathogenesis of diseases characterized by monocytic infiltrates, like psoriasis, rheumatoid arthritis or atherosclerosis. May be involved in the recruitment of monocytes into the arterial wall during the disease process of atherosclerosis. Binds to CCR2 and CCR4.

(continued)

Peptide	Amino acid sequence	Function
CCL18 (small inducible cytokine A18) Swiss-Prot: P55774	QVGTNKELC CLVYTSWQIP QKFIVDYSET SPQCPKPGVI LLTKRGRQIC ADPNKKWVQK YISDLKLNA	Chemotactic factor that attracts lymphocytes but not monocytes or granulocytes. May be involved in B cell migration into B cell follicles in lymph nodes. Attracts naive T lymphocytes toward dendritic cells and activated macrophages in lymph nodes, has chemotactic activity for naive T cells, CD4+ and CD8+ T cells and thus may play a role in both humoral and cell-mediated immunity responses.
Fractalkine (neurotactin) Swiss-Prot: P78423	QHHGVT KCNITCSKMT SKIPVALLIH YQQNQASCGK RAIILETRQH RLFCADPKEQ WVKDAMQHLD RQAAALTRNG GTFEKQIGEV KPRTTPAAGG MDESVVLEPE ATGESSSLEP TPSSQEAQRA LGTSPELPTG VTGSSGTRLP PTPKAQDGGP VGTELFRVPP VSTAATWQSS APHQPGPSLW AEAKTSEAPS TQDPSTQAST ASSPAPEENA PSEGQRVWGQ GQSPRPENSL EREEMGPVPA HTDAFQDWGP GSMAHVSVVP VSSEGTPSRE PVASGSWTPK AEEPIHATMD PQRLGVLITP VPDAQAATRR QAVGLLAFLG LLFCLGVAMF TYQSLQGCPR KMAGEMAEGL RYIPRSCGSN SYVLVPV	The soluble form is chemotactic for T cells and monocytes, but not for neutrophils. The membrane-bound form promotes adhesion of those leukocytes to endothelial cells. May play a role in regulating leukocyte adhesion and migration processes at the endothelium binds to CX3CR1.
CCL7 (small inducible cytokine A7) Swiss-Prot: P80098	QPVGINT STTCCYRFIN KKIPKQRLES YRRTTSSHCP REAVIFKTKL DKEICADPTQ KWVQDFMKHL DKKTQTPKL	Chemotactic factor that attracts monocytes and eosinophils, but not neutrophils. Augments monocyte anti-tumor activity. Also induces the release of gelatinase B. This protein can bind heparin. Binds to CCR1, CCR2 and CCR3.

(continued)

Peptide	Amino acid sequence	Function
Orexin A (Hypocretin-1) Swiss-Prot 043612	QPLPDCCRQK TCSCRLYELL HGAGNHAAGI LTL	Neuropeptide that plays a significant role in the regulation of food intake and sleep-wakefulness, possibly by coordinating the complex behavioral and physiologic responses of these complementary homeostatic functions. It plays also a broader role in the homeostatic regulation of energy metabolism, autonomic function, hormonal balance and the regulation of body fluids. Orexin-A binds to both OX1R and OX2R with a high affinity.
Substance P	RPK PQQFFGLM	Belongs to the tachykinins. Tachykinins are active peptides which excite neurons, evoke behavioral responses, are potent vasodilators and secretagogues, and contract (directly or indirectly) many smooth muscles.
QYNAD	Gln-Tyr-Asn-Ala-Asp	Acts on voltage-gated sodium channels.

[0073] Glutamate is found in positions 3, 11 and 22 of the amyloid β-peptide. Among them the mutation from glutamic acid (E) to glutamine (Q) in position 22 (corresponding to amyloid precursor protein APP 693, Swissprot P05067) has been described as the so called Dutch type cerebroarterial amyloidosis mutation.

[0074] The β-amyloid peptides with a pyroglutamic acid residue in position 3, 11 and/or 22 have been described to be more cytotoxic and hydrophobic than the amyloid β-peptides 1-40(42/43) (Saido T.C. 2000 Medical Hypotheses 54 (3): 427-429).

[0075] The multiple N-terminal variations, e.g. Abeta(3-40), Abeta(3-42), Abeta(11-40) and Abeta (11-42) can be generated by the β-secretase enzyme β-site amyloid precursor protein-cleaving enzyme (BACE) at different sites (Huse J.T. et al. 2002 J. Biol. Chem. 277 (18): 16278-16284), and/or by aminopeptidase or dipeptidylaminopeptidase processing from the full lenght peptides Abeta(1-40) and Abeta(1-42). In all cases, cyclization of the then N-terminal occuring glutamic acid residue is catalyzed by QC.

[0076] Transepithelial transducing cells, particularly the gastrin (G) cell, co-ordinate gastric acid secretion with the arrival of food in the stomach. Recent work showed that multiple active products are generated from the gastrin precursor, and that there are multiple control points in gastrin biosynthesis. Biosynthetic precursors and intermediates (progastrin and Gly-gastrins) are putative growth factors; their products, the amidated gastrins, regulate epithelial cell proliferation, the differentiation of acid-producing parietal cells and histamine-secreting enterochromaffin-like (ECL) cells, and the expression of genes associated with histamine synthesis and storage in ECL cells, as well as acutely stimulating acid secretion. Gastrin also stimulates the production of members of the epidermal growth factor (EGF) family, which in turn inhibit parietal cell function but stimulate the growth of surface epithelial cells. Plasma gastrin concentrations are elevated in subjects with *Helicobacter pylori,* who are known to have increased risk of duodenal ulcer disease and gastric cancer (Dockray, G.J. 1999 J Physiol 15 315-324).

[0077] The peptide hormone gastrin, released from antral G cells, is known to stimulate the synthesis and release of histamine from ECL cells in the oxyntic mucosa via CCK-2 receptors. The mobilized histamine induces acid secretion by binding to the H(2) receptors located on parietal cells. Recent studies suggest that gastrin, in both its fully amidated and less processed forms (progastrin and glycine-extended gastrin), is also a growth factor for the gastrointestinal tract.

It has been established that the major trophic effect of amidated gastrin is for the oxyntic mucosa of stomach, where it causes increased proliferation of gastric stem cells and ECL cells, resulting in increased parietal and ECL cell mass. On the other hand, the major trophic target of the less processed gastrin (e.g. glycine-extended gastrin) appears to be the colonic mucosa (Koh, T.J. and Chen, D. 2000 Regul Pept 9337-44).

[0078] Neurotensin (NT) is a neuropeptide implicated in the pathophysiology of schizophrenia that specifically modulates neurotransmitter systems previously demonstrated to be misregulated in this disorder. Clinical studies in which cerebrospinal fluid (CSF) NT concentrations have been measured revealed a subset of schizophrenic patients with decreased CSF NT concentrations that are restored by effective antipsychotic drug treatment. Considerable evidence also exists concordant with the involvement of NT systems in the mechanism of action of antipsychotic drugs. The behavioral and biochemical effects of centrally administered NT remarkably resemble those of systemically administered antipsychotic drugs, and antipsychotic drugs increase NT neurotransmission. This concatenation of findings led to the hypothesis that NT functions as an endogenous antipsychotic. Moreover, typical and atypical antipsychotic drugs differentially alter NT neurotransmission in nigrostriatal and mesolimbic dopamine terminal regions, and these effects are predictive of side effect liability and efficacy, respectively (Binder, E. B. et al. 2001 Biol Psychiatry 50 856-872).

[0079] Fertilization promoting peptide (FPP), a tripeptide related to thyrotrophin releasing hormone (TRH), is found in seminal plasma. Recent evidence obtained *in vitro* and *in vivo* showed that FPP plays an important role in regulating sperm fertility. Specifically, FPP initially stimulates nonfertilizing (uncapacitated) spermatozoa to "switch on" and become fertile more quickly, but then arrests capacitation so that spermatozoa do not undergo spontaneous acrosome loss and therefore do not lose fertilizing potential. These responses are mimicked, and indeed augmented, by adenosine, known to regulate the adenylyl cyclase (AC)/cAMP signal transduction pathway. Both FPP and adenosine have been shown to stimulate cAMP production in uncapacitated cells but inhibit it in capacitated cells, with FPP receptors somehow interacting with adenosine receptors and G proteins to achieve regulation of AC. These events affect the tyrosine phosphorylation state of various proteins, some being important in the initial "switching on," others possibly being involved in the acrosome reaction itself. Calcitonin and angiotensin II, also found in seminal plasma, have similar effects *in vitro* on uncapacitated spermatozoa and can augment responses to FPP. These molecules have similar effects *in vivo,* affecting fertility by stimulating and then maintaining fertilizing potential. Either reductions in the availability of FPP, adenosine, calcitonin, and angiotensin II or defects in their receptors contribute to male infertility (Fraser, L.R. and Adeoya-Osiguwa, S. A. 2001 Vitam Horm 63, 1-28).

[0080] CCL2 (MCP-1), CCL7, CCL8, CCL16, CCL18 and fractalkine play an important role in pathophysiological conditions, such as suppression of proliferation of myeloid progenitor cells, neoplasia, inflammatory host responses, cancer, psoriasis, rheumatoid arthritis, atherosclerosis, vasculitis, humoral and cell-mediated immunity responses, leukocyte adhesion and migration processes at the endothelium, inflammatory bowel disease, restenosis, pulmonary fibrosis, pulmonary hypertention, liver fibrosis, liver cirrhosis, nephrosclerosis, ventricular remodeling, heart failure, arteriopathy after organ transplantations and failure of vein grafts.

[0081] A number of studies have underlined in particular the crucial role of MCP-1 for the development of atherosclerosis (Gu, L., et al., (1998) Mol.cell 2, 275-281; Gosling, J., et al., (1999) J Clin.Invest 103, 773-778); rheumatoid arthritis (Gong, J. H., et al., (1997) J Exp.Med 186, 131-137; Ogata, H., et al., (1997) J Pathol. 182, 106-114); pancreatitis (Bhatia, M., et al., (2005) Am.J Physiol Gastrointest. Liver Physiol 288, G1259-G1265); Alzheimer's disease (Yamamoto, M., et al., (2005) Am.J Pathol. 166, 1475-1485); lung fibrosis (Inoshima, I., et al., (2004) Am.J Physiol Lung Cell Mol.Physiol 286, L1038-L1044); renal fibrosis (Wada, T., et al., (2004) J Am.Soc.Nephrol. 15, 940-948), and graft rejection (Saiura, A., et al., (2004) Arterioscler. Thromb. Vasc. Biol. 24, 1886-1890). Furthermore, MCP-1 might also play a role in gestosis (Katabuchi, H., et al., (2003) Med Electron Microsc. 36, 253-262), as a paracrine factor in tumor development (Ohta, M., et al., (2003) Int.J Oncol. 22, 773-778; Li, S., et al., (2005) J Exp.Med 202, 617-624), neuropathic pain (White, F. A., et al., (2005) Proc. Natl. Acad.Sci.U.S.A*)* and AIDS (Park, I. W., Wang, J. F., and Groopman, J. E. (2001) Blood 97, 352-358*;* Coll, B., et al., (2006) Cytokine 34, 51-55).

[0082] MCP-1 levels are increased in CSF of AD patients and patients showing mild cognitive impairment (MCI) (Galimberti, D., et al., (2006) Arch.Neurol. 63, 538-543). Furthermore, MCP-1 shows an increased level in serum of patients with MCI and early AD (Clerici, F., et al., (2006) Neurobiol.Aging 27, 1763-1768).

[0083] Several cytotoxic T lymphocyte peptide-based vaccines against hepatitis B, human immunodeficiency virus and melanoma were recently studied in clinical trials. One interesting melanoma vaccine candidate alone or in combination with other tumor antigens, is the decapeptide ELA. This peptide is a Melan-A/MART-1 antigen immunodominant peptide analog, with an N-terminal glutamic acid. It has been reported that the amino group and gamma-carboxylic group of glutamic acids, as well as the amino group and gamma-carboxamide group of glutamines, condense easily to form pyroglutamic derivatives. To overcome this stability problem, several peptides of pharmaceutical interest have been developed with a pyroglutamic acid instead of N-terminal glutamine or glutamic acid, without loss of pharmacological properties. Unfortunately compared with ELA, the pyroglutamic acid derivative (PyrELA) and also the N-terminal acetyl-capped derivative (AcELA) failed to elicit cytotoxic T lymphocyte (CTL) activity. Despite the apparent minor modifications introduced in PyrELA and AcELA, these two derivatives probably have lower affinity than ELA for the specific class I

major histocompatibility complex. Consequently, in order to conserve full activity of ELA, the formation of PyrELA must be avoided (Beck A. et al. 2001, J Pept Res 57(6):528-38.).

[0084] Orexin A is a neuropeptide that plays a significant role in the regulation of food intake and sleep-wakefulness, possibly by coordinating the complex behavioral and physiologic responses of these complementary homeostatic functions. It plays also a role in the homeostatic regulation of energy metabolism, autonomic function, hormonal balance and the regulation of body fluids.

[0085] Recently, increased levels of the pentapeptide QYNAD were identified in the cerebrospinal fluid (CSF) of patients suffering from multiple sclerosis or Guillain-Barré syndrome compared to healthy individuals (Brinkmeier H. et al. 2000, Nature Medicine 6, 808-811). There is a big controversy in the literature about the mechanism of action of the pentapeptide Gln-Tyr-Asn-Ala-Asp (QYNAD), especially its efficacy to interact with and block sodium channels resulting in the promotion of axonal dysfunction, which are involved in inflammatory autoimmune diseases of the central nervous system. But recently, it could be demonstrated that not QYNAD, but its cyclized, pyroglutamated form, pEYNAD, is the active form, which blocks sodium channels resulting in the promotion of axonal dysfunction. Sodium channels are expressed at high density in myelinated axons and play an obligatory role in conducting action potentials along axons within the mammalian brain and spinal cord. Therefore, it is speculated that they are involved in several aspects of the pathophysiology of inflammatory autoimmune diseases, especially multiple sclerosis, the Guillain-Barré syndrome and chronic inflammatory demyelinizing polyradiculoneuropathy.

Furthermore, QYNAD is a substrate of the enzyme glutaminyl cyclase (QC, EC 2.3.2.5), which is also present in the brain of mammals, especially in human brain. Glutaminyl cyclase catalyzes effectively the formation of pEYNAD from its precursor QYNAD.

[0086] Accordingly, the present invention provides the use of the compounds of formula (I) for the preparation of a medicament for the prevention or alleviation or treatment of a disease selected from the group consisting of mild cognitive impairment, Alzheimer's disease, Familial British Dementia, Familial Danish Dementia, neurodegeneration in Down Syndrome, Huntington's disease, Kennedy's disease, ulcer disease, duodenal cancer with or w/o *Helicobacter pylori* infections, colorectal cancer, Zolliger-Ellison syndrome, gastric cancer with or without *Helicobacter pylori* infections, pathogenic psychotic conditions, schizophrenia, infertility, neoplasia, inflammatory host responses, cancer, malign metastasis, melanoma, psoriasis, rheumatoid arthritis, atherosclerosis, pancreatitis, restenosis, impaired humoral and cell-mediated immune responses, leukocyte adhesion and migration processes in the endothelium, impaired food intake, impaired sleep-wakefulness, impaired homeostatic regulation of energy metabolism, impaired autonomic function, impaired hormonal balance or impaired regulation of body fluids, multiple sclerosis, the Guillain-Barré syndrome and chronic inflammatory demyelinizing polyradiculoneuropathy.

[0087] Furthermore, by administration of a compound according to the present invention to a mammal it can be possible to stimulate the proliferation of myeloid progenitor cells.

[0088] In addition, the administration of a QC inhibitor according to the present invention can lead to suppression of male fertility.

[0089] In a preferred embodiment, the present invention provides the use of inhibitors of QC (EC) activity in combination with other agents, especially for the treatment of neuronal diseases, artherosclerosis and multiple sclerosis.

[0090] The present invention also provides a method of treatment of the aforementioned diseases comprising the administration of a therapeutically active amount of at least one compound of formula (I) to a mammal, preferably a human.

[0091] Most preferably, said method and corresponding uses are for the treatment of a disease selected from the group consisting of mild cognitive impairment, Alzheimer's disease, Familial British Dementia, Familial Danish Dementia, neurodegeneration in Down Syndrome, Parkinson disease and Chorea Huntington, comprising the administration of a therapeutically active amount of at least one compound of formula (I) to a mammal, preferably a human.

[0092] Even preferably, the present invention provides a method of treatment and corresponding uses for the treatment of rheumatoid arthritis, atherosclerosis, pancreatitis and restenosis.

Pharmaceutical combinations

[0093] In a preferred embodiment, the present invention provides a composition, preferably a pharmaceutical composition, comprising at least one QC inhibitor optionally in combination with at least one other agent selected from the group consisting of nootropic agents, neuroprotectants, antiparkinsonian drugs, amyloid protein deposition inhibitors, beta amyloid synthesis inhibitors, antidepressants, anxiolytic drugs, antipsychotic drugs and anti-multiple sclerosis drugs.

[0094] Most preferably, said QC inhibitor is a compound of formula (I) of the present invention.

[0095] More specifically, the aforementioned other agent is selected from the group consisting of beta-amyloid antibodies, cysteine protease inhibitors, PEP-inhibitors, LiCl, acetylcholinesterase (AChE) inhibitors, PIMT enhancers, inhibitors of beta secretases, inhibitors of gamma secretases, inhibitors of aminopeptidases, preferably inhibitors of dipeptidyl peptidases, most preferably DP IV inhibitors; inhibitors of neutral endopeptidase, inhibitors of Phosphodiesterase-4 (PDE-4), TNFalpha inhibitors, muscarinic M1 receptor antagonists, NMDA receptor antagonists, sigma-1 receptor

inhibitors, histamine H3 antagonists, immunomodulatory agents, immunosuppressive agents, MCP-1 antagonists or an agent selected from the group consisting of antegren (natalizumab), Neurelan (fampridine-SR), campath (alemtuzumab), IR 208, NBI 5788/MSP 771 (tiplimotide), paclitaxel, Anergix.MS (AG 284), SH636, Differin (CD 271, adapalene), BAY 361677 (interleukin-4), matrix-metalloproteinase-inhibitors (e.g. BB 76163), interferon-tau (trophoblastin) and SAIK-MS.

[0096] Furthermore, the other agent may be, for example, an anti-anxiety drug or antidepressant selected from the group consisting of

(a) Benzodiazepines, e.g. alprazolam, chlordiazepoxide, clobazam, clonazepam, clorazepate, diazepam, fludiazepam, loflazepate, lorazepam, methaqualone, oxazepam, prazepam, tranxene,
(b) Selective serotonin re-uptake inhibitors (SSRI's), e.g. citalopram, fluoxetine, fluvoxamine, escitalopram, sertraline, paroxetine,
(c) Tricyclic antidepressants, e.g. amitryptiline, clomipramine, desipramine, doxepin, imipramine
(d) Monoamine oxidase (MAO) inhibitors,
(e) Azapirones, e.g. buspirone, tandopsirone,
(f) Serotonin-norepinephrine reuptake inhibitors (SNRI's), e.g. venlafaxine, duloxetine,
(g) Mirtazapine,
(h) Norepinephrine reuptake inhibitors (NRI's), e.g. reboxetine,
(i) Bupropione,
(j) Nefazodone,
(k) beta-blockers,
(l) NPY-receptor ligands: NPY agonists or antagonists.

[0097] In a further embodiment, the other agent may be, for example, an anti-multiple sclerosis drug selected from the group consisting of

a) dihydroorotate dehydrogenase inhibitors, e.g. SC-12267, teriflunomide, MNA-715, HMR-1279 (syn. to HMR-1715, MNA-279),
b) autoimmune suppressant, e.g. laquinimod,
c) paclitaxel,
d) antibodies, e.g. AGT-1, anti-granulocyte-macrophage colony-stimulating factor (GM-CSF) monoclonal antibody, Nogo receptor modulators, ABT-874, alemtuzumab (CAMPATH), anti-OX40 antibody, CNTO-1275, DN-1921, natalizumab (syn. to AN-100226, Antegren, VLA-4 Mab), daclizumab (syn. to Zenepax, Ro-34-7375, SMART anti-Tac), J-695, priliximab (syn. to Centara, CEN-000029, cM-T412), MRA, Dantes, anti-IL-12-antibody,
e) peptide nucleic acid (PNA) preparations, e.g. reticulose,
f) interferon alpha, e.g. Alfaferone, human alpha interferon (syn. to Omniferon, Alpha Leukoferon),
g) interferon beta, e.g. Frone, interferon beta-1a like Avonex, Betron (Rebif), interferon beta analogs, interferon beta-transferrin fusion protein, recombinant interferon beta-1b like Betaseron,
h) interferon tau,
i) peptides, e.g. AT-008, AnergiX.MS, Immunokine (alpha-Immunokine-NNSO3), cyclic peptides like ZD-7349,
j) therapeutic enzymes, e.g. soluble CD8 (sCD8),
k) multiple sclerosis-specific autoantigen-encoding plasmid and cytokine-encoding plasmid, e.g. BHT-3009;
l) inhibitor of TNF-alpha, e.g. BLX-1002, thalidomide, SH-636,
m) TNF antagonists, e.g. solimastat, lenercept (syn. to RO-45-2081, Tenefuse), onercept (sTNFR1), CC-1069,
n) TNF alpha, e.g. etanercept (syn. to Enbrel, TNR-001)
o) CD28 antagonists, e.g. abatacept,
p) Lck tyrosine kinase inhibitors,
q) cathepsin K inhibitors,
r) analogs of the neuron-targeting membrane transporter protein taurine and the plant-derived calpain inhibitor leupeptin, e.g. Neurodur,
s) chemokine receptor-1 (CCR1) antagonist, e.g. BX-471,
t) CCR2 antagonists,
u) AMPA receptor antagonists, e.g. ER-167288-01 and ER-099487, E-2007, talampanel,
v) potassium channel blockers, e.g. fampridine,
w) tosyl-proline-phenylalanine small-molecule antagonists of the VLA-4NCAM interaction, e.g. TBC-3342,
x) cell adhesion molecule inhibitors, e.g. TBC-772,
y) antisense oligonucleotides, e.g. EN-101,
z) antagonists of free immunoglobulin light chain (IgLC) binding to mast cell receptors, e.g. F-991,
aa) apoptosis inducing antigens, e.g. Apogen MS,

bb) alpha-2 adrenoceptor agonist, e.g. tizanidine (syn. to Zanaflex, Ternelin, Sirdalvo, Sirdalud, Mionidine),
cc) copolymer of L-tyrosine, L-lysine, L-glutamic acid and L-alanine, e.g. glatiramer acetate (syn. to Copaxone, COP-1, copolymer-1),
dd) topoisomerase II modulators, e.g. mitoxantrone hydrochloride,
ee) adenosine deaminase inhibitor, e.g. cladribine (syn. to Leustatin, Mylinax, RWJ-26251),
ff) interleukin-10, e.g. ilodecakin (syn. to Tenovil, Sch-52000, CSIF),
gg) interleukin-12 antagonists, e.g. lisofylline (syn. to CT-1501R, LSF, lysofylline),
hh) Ethanaminum, e.g. SRI-62-834 (syn. to CRC-8605, NSC-614383),
ii) immunomodulators, e.g. SAIK-MS, PNU-156804, alpha-fetoprotein peptide (AFP), IPDS,
jj) retinoid receptor agonists, e.g. adapalene (syn. to Differin, CD-271),
kk) TGF-beta, e.g. GDF-1 (growth and differentiation factor 1),
ll) TGF-beta-2, e.g. BetaKine,
mm) MMP inhibitors, e.g. glycomed,
nn) phosphodiesterase 4 (PDE4) inhibitors, e.g. RPR-122818,
oo) purine nucleoside phosphorylase inhibitors, e.g. 9-(3-pyridylmethyl)-9-deazaguanine, peldesine (syn. to BCX-34, TO-200),
pp) alpha-4/beta-1 integrin antagonists, e.g. ISIS-104278,
qq) antisense alpha4 integrin (CD49d), e.g. ISIS-17044, ISIS-27104,
rr) cytokine-inducing agents, e.g. nucleosides, ICN-17261,
ss) cytokine inhibitors,
tt) heat shock protein vaccines, e.g. HSPPC-96,
uu) neuregulin growth factors, e.g. GGF-2 (syn. to neuregulin, glial growth factor 2),
vv) cathepsin S - inhibitors,
ww) bropirimine analogs, e.g. PNU-56169, PNU-63693,
xx) Monocyte chemoattractant protein-1 inhibitors, e.g. benzimidazoles like MCP-1 inhibitors, LKS-1456, PD-064036, PD-064126, PD-084486, PD-172084, PD-172386.

[0098] Further, the present invention provides pharmaceutical compositions e.g. for parenteral, enteral or oral administration, comprising at least one QC inhibitor, optionally in combination with at least one of the other aforementioned agents.

[0099] These combinations provide a particularly beneficial effect. Such combinations are therefore shown to be effective and useful for the treatment of the aforementioned diseases. Accordingly, the invention provides a method for the treatment of these conditions.

[0100] The method comprises either co-administration of at least one QC inhibitor and at least one of the other agents or the sequential administration thereof.

[0101] Co-administration includes administration of a formulation, which comprises at least one QC inhibitor and at least one of the other agents or the essentially simultaneous administration of separate formulations of each agent.

[0102] Beta-amyloid antibodies and compositions containing the same are described, e.g. in WO 2006/137354, WO 2006/118959, WO 2006/103116, WO 2006/095041, WO 2006/081171, WO 2006/066233, WO 2006/066171, WO 2006/066089, WO 2006/066049, WO 2006/055178, WO 2006/046644, WO 2006/039470, WO 2006/036291, WO 2006/026408, WO 2006/016644, WO 2006/014638, WO 2006/014478, WO 2006/008661, WO 2005/123775, WO 2005/120571, WO 2005/105998, WO 2005/081872, WO 2005/080435, WO 2005/028511, WO 2005/025616, WO 2005/025516, WO 2005/023858, WO 2005/018424, WO 2005/011599, WO 2005/000193, WO 2004/108895, WO 2004/098631, WO 2004/080419, WO 2004/071408, WO 2004/069182, WO 2004/067561, WO 2004/044204, WO 2004/032868, WO 2004/031400, WO 2004/029630, WO 2004/029629, WO 2004/024770, WO 2004/024090, WO 2003/104437, WO 2003/089460, WO 2003/086310, WO 2003/077858, WO 2003/074081, WO 2003/070760, WO 2003/063760, WO 2003/055514, WO 2003/051374, WO 2003/048204, WO 2003/045128, WO 2003/040183, WO 2003/039467, WO 2003/016466, WO 2003/015691, WO 2003/014162, WO 2003/012141, WO 2002/088307, WO 2002/088306, WO 2002/074240, WO 2002/046237, WO 2002/046222, WO 2002/041842, WO 2001/062801, WO 2001/012598, WO 2000/077178, WO 2000/072880, WO 2000/063250, WO 1999/060024, WO 1999/027944, WO 1998/044955, WO 1996/025435, WO 1994/017197, WO 1990/014840, WO 1990/012871, WO 1990/012870, WO 1989/006242.

[0103] The beta-amyloid antibodies may be selected from, for example, polyclonal, monoclonal, chimenic or humanized antibodies. Furthermore, said antibodies may be useful to develop active and passive immune therapies, i.e. vaccines and monoclonal antibodies.

Suitable examples of beta-amyloid antibodies are ACU-5A5, huC091 (Acumen/Merck); PF-4360365, RI-1014, RI-1219, RI-409, RN-1219 (Rinat Neuroscience Corp (Pfizer Inc)); the nanobody therapeutics of Ablynx/Boehringer Ingelheim; beta-amyloid-specific humanized monoclonal antibodies of Intellect Neurosciences/IBL; m266, m266.2 (Eli Lilly & Co.);

AAB-02 (Elan); bapineuzumab (Elan); BAN-2401 (Bioarctic Neuroscience AB); ABP-102 (Abiogen Pharma SpA); BA-27, BC-05 (Takeda); R-1450 (Roche); ESBA-212 (ESBATech AG); AZD-3102 (AstraZeneca) and beta-amyloid antibodies of Mindset BioPharmaceuticals Inc.

[0104] Especially preferred are antibodies, which recognize the N-terminus of the Aβ peptide. A suitable antibody, which recognizes the Aβ-N-Terminus is, for example Acl-24 (AC Immune SA). A monoclonal antibody against beta-amyloid peptide is disclosed in WO 2007/068412. Respective chimeric and humanized antibodies are disclosed in WO 2008/011348. A method for producing a vaccine composition for treating an amyloid-associated disease is disclosed in WO 2007/068411.

[0105] Suitable cysteine protease inhibitors are inhibitors of cathepsin B and compositions containing such inhibitors are described, e.g. in WO 2006/060473, WO 2006/042103, WO 2006/039807, WO 2006/021413, WO 2006/021409, WO 2005/097103, WO 2005/007199, WO2004/084830, WO 2004/078908, WO 2004/026851, WO 2002/094881, WO 2002/027418, WO 2002/021509, WO 1998/046559, WO 1996/021655.

[0106] Examples of suitable PIMT enhancers are 10-aminoaliphatyl-dibenz[b, f] oxepines described in WO 98/15647 and WO 03/057204, respectively. Further useful according to the present invention are modulators of PIMT activity described in WO 2004/039773.

[0107] Inhibitors of beta secretase and compositions containing such inhibitors are described, e.g. in WO03/059346, WO2006/099352, WO2006/078576, WO2006/060109, WO2006/057983, WO2006/057945, WO2006/055434, W02006/044497, WO2006/034296, W02006/034277, WO2006/029850, WO2006/026204, WO2006/014944, WO2006/014762, WO2006/002004, US 7,109,217, W02005/113484, W02005/103043, W02005/103020, WO2005/065195, WO2005/051914, WO2005/044830, WO2005/032471, WO2005/018545, WO2005/004803, WO2005/004802, WO2004/062625, WO2004/043916, WO2004/013098, WO03/099202, WO03/043987, WO03/039454, US 6,562,783, WO02/098849 and WO02/096897.

[0108] Suitable examples of beta secretase inhibitors for the purpose of the present invention are WY-25105 (Wyeth); Posiphen, (+)-phenserine (TorreyPines / NIH); LSN-2434074, LY-2070275, LY-2070273, LY-2070102 (Eli Lilly & Co.); PNU-159775A, PNU-178025A, PNU-17820A, PNU-33312, PNU-38773, PNU-90530 (Elan / Pfizer); KMI-370, KMI-358, kmi-008 (Kyoto University); OM-99-2, OM-003 (Athenagen Inc.); AZ-12304146 (AstraZeneca / Astex); GW-840736X (GlaxoSmithKline plc.), DNP-004089 (De Novo Pharmaceuticals Ltd.) and CT-21166 (Comentis Inc.).

[0109] Inhibitors of gamma secretase and compositions containing such inhibitors are described, e.g. in WO 2005/008250, WO 2006/004880, US 7,122,675, US 7,030,239, US 6,992,081, US 6,982,264, WO 2005/097768, WO 2005/028440, WO 2004/101562, US 6,756,511, US 6,683,091, WO 03/066592, WO 03/014075, WO 03/013527, WO 02/36555, WO 01/53255, US 7,109,217, US 7,101,895, US 7,049,296, US 7,034,182, US 6,984,626, WO 2005/040126, WO 2005/030731, WO 2005/014553, US 6,890,956, EP 1334085, EP 1263774, WO 2004/101538, WO 2004/00958, WO 2004/089911, WO 2004/073630, WO 2004/069826, WO 2004/039370, WO 2004/031139, WO 2004/031137, US 6,713,276, US 6,686,449, WO 03/091278, US 6,649,196, US 6,448,229, WO 01/77144 and WO 01/66564.

[0110] Suitable gamma secretase inhibitors for the purpose of the present invention are GSI-953, WAY-GSI-A, WAY-GSI-B (Wyeth); MK-0752, MRK-560, L-852505, L-685-458, L-852631, L-852646 (Merck & Co. Inc.); LY-450139, LY-411575, AN-37124 (Eli Lilly & Co.); BMS-299897, BMS-433796 (Bristol-Myers Squibb Co.); E-2012 (Eisai Co. Ltd.); EHT-0206, EHT-206 (ExonHit Therapeutics SA); and NGX-555 (TorreyPines Therapeutics Inc.).

[0111] DP IV-inhibitors and compositions containing such inhibitors are described, e.g. in US6,011,155; US6,107,317; US6,110,949; US6,124,305; US6,172,081; WO 99/61431, WO 99/67278, WO 99/67279, DE 19834591, WO 97/40832, WO 95/15309, WO 98/19998, WO 00/07617, WO 99/38501, WO 99/46272, WO 99/38501, WO 01/68603, WO 01/40180, WO 01/81337, WO 01/81304, WO 01/55105, WO 02/02560, WO 01/34594, WO 02/38541, WO 02/083128, WO 03/072556, WO 03/002593, WO 03/000250, WO 03/000180, WO 03/000181, EP1258476, WO 03/002553, WO 03/002531, WO 03/002530, WO 03/004496, WO 03/004498, WO 03/024942, WO 03/024965, WO 03/033524, WO 03/035057, WO 03/035067, WO 03/037327, WO 03/040174, WO 03/045977, WO 03/055881, WO 03/057144, WO 03/057666, WO 03/068748, WO 03/068757, WO 03/082817, WO 03/101449, WO 03/101958, WO 03/104229, WO 03/74500, WO 2004/007446, WO 2004/007468, WO 2004/018467, WO 2004/018468, WO 2004/018469, WO 2004/026822, WO 2004/032836, WO 2004/033455, WO 2004/037169, WO 2004/041795, WO 2004/043940, WO 2004/048352, WO 2004/050022, WO 2004/052850, WO 2004/058266, WO 2004/064778, WO 2004/069162, WO 2004/071454, WO 2004/076433, WO 2004/076434, WO 2004/087053, WO 2004/089362, WO 2004/099185, WO 2004/103276, WO 2004/103993, WO 2004/108730, WO 2004/110436, WO 2004/111041, WO 2004/112701, WO 2005/000846, WO 2005/000848, WO 2005/011581, WO 2005/016911, WO 2005/023762, WO 2005/025554, WO 2005/026148, WO 2005/030751, WO 2005/033106, WO 2005/037828, WO 2005/040095, WO 2005/044195, WO 2005/047297, WO 2005/051950, WO 2005/056003, WO 2005/056013, WO 2005/058849, WO 2005/075426, WO 2005/082348, WO 2005/085246, WO 2005/087235, WO 2005/095339, WO 2005/095343, WO 2005/095381, WO 2005/108382, WO 2005/113510, WO 2005/116014, WO 2005/116029, WO 2005/118555, WO 2005/120494, WO 2005/121089, WO 2005/121131, WO 2005/123685, WO 2006/995613; WO 2006/009886; WO 2006/013104; WO 2006/017292; WO 2006/019965; WO 2006/020017; WO 2006/023750; WO 2006/039325; WO 2006/041976; WO

2006/047248; WO 2006/058064; WO 2006/058628; WO 2006/066747; WO 2006/066770 and WO 2006/068978.

[0112] Suitable DP IV-inhibitors for the purpose of the present invention are for example Sitagliptin, des-fluoro-sitagliptin (Merck & Co. Inc.); vildagliptin, DPP-728, SDZ-272-070 (Novartis) ; ABT-279, ABT-341 (Abbott Laboratories); denagliptin, TA-6666 (GlaxoSmithKline plc.); SYR-322 (Takeda San Diego Inc.); talabostat (Point Therapeutics Inc.); Ro-0730699, R-1499, R-1438 (Roche Holding AG); FE-999011 (Ferring Pharmaceuticals); TS-021 (Taisho Pharmaceutical Co. Ltd.); GRC-8200 (Glenmark Pharmaceuticals Ltd.); ALS-2-0426 (Alantos Pharmaceuticals Holding Inc.); ARI-2243 (Arisaph Pharmaceuticals Inc.); SSR-162369 (Sanofi-Synthelabo); MP-513 (Mitsubishi Pharma Corp.); DP-893, CP-867534-01 (Pfizer Inc.); TSL-225, TMC-2A (Tanabe Seiyaku Co. Ltd.); PHX-1149 (Phenomenix Corp.); saxagliptin (Bristol-Myers Squibb Co.); PSN-9301 ((OSI) Prosidion), S-40755 (Servier); KRP-104 (ActivX Biosciences Inc.); sulphostin (Zaidan Hojin); KR-62436 (Korea Research Institute of Chemical Technology); P32/98 (Probiodrug AG); BI-A, BI-B (Boehringer Ingelheim Corp.); SK-0403 (Sanwa Kagaku Kenkyusho Co. Ltd.); and NNC-72-2138 (Novo Nordisk A/S).

[0113] Other preferred DP IV-inhibitors are

(i) dipeptide-like compounds, disclosed in WO 99/61431, e.g. N-valyl prolyl, O-benzoyl hydroxylamine, alanyl pyrrolidine, isoleucyl thiazolidine like L-allo-isoleucyl thiazolidine, L-threo-isoleucyl pyrrolidine and salts thereof, especially the fumaric salts, and L-allo-isoleucyl pyrrolidine and salts thereof;
(ii) peptide structures, disclosed in WO 03/002593, e.g. tripeptides;
(iii) peptidylketones, disclosed in WO 03/033524;
(vi) substituted aminoketones, disclosed in WO 03/040174;
(v) topically active DP IV-inhibitors, disclosed in WO 01/14318;
(vi) prodrugs of DP IV-inhibitors, disclosed in WO 99/67278 and WO 99/67279; and
(v) glutaminyl based DP IV-inhibitors, disclosed in WO 03/072556 and WO 2004/099134.

[0114] Suitable beta amyloid synthesis inhibitors for the purpose of the present invention are for example Bisnorcymserine (Axonyx Inc.); (R)-flurbiprofen (MCP-7869; Flurizan) (Myriad Genetics); nitroflurbiprofen (NicOx); BGC-20-0406 (Sankyo Co. Ltd.) and BGC-20-0466 (BTG plc.).

[0115] Suitable amyloid protein deposition inhibitors for the purpose of the present invention are for example SP-233 (Samaritan Pharmaceuticals); AZD-103 (Ellipsis Neurotherapeutics Inc.); AAB-001 (Bapineuzumab), AAB-002, ACC-001 (Elan Corp plc.); Colostrinin (ReGen Therapeutics plc.); Tramiprosate (Neurochem); AdPEDI-(amyloid-beta1-6)11) (Vaxin Inc.); MPI-127585, MPI-423948 (Mayo Foundation); SP-08 (Georgetown University); ACU-5A5 (Acumen / Merck); Transthyretin (State University of New York); PTI-777, DP-74, DP 68, Exebryl (ProteoTech Inc.); m266 (Eli Lilly & Co.); EGb-761 (Dr. Willmar Schwabe GmbH); SPI-014 (Satori Pharmaceuticals Inc.); ALS-633, ALS-499 (Advanced Life Sciences Inc.); AGT-160 (ArmaGen Technologies Inc.); TAK-070 (Takeda Pharmaceutical Co. Ltd.); CHF-5022, CHF-5074, CHF-5096 and CHF-5105 (Chiesi Farmaceutici SpA.).

[0116] Suitable PDE-4 inhibitors for the purpose of the present invention are for example Doxofylline (Instituto Biologico Chemioterapica ABC SpA.); idudilast eye drops, tipelukast, ibudilast (Kyorin Pharmaceutical Co. Ltd.); theophylline (Elan Corp.); cilomilast (GlaxoSmithKline plc.); Atopik (Barrier Therapeutics Inc.); tofimilast, CI-1044, PD-189659, CP-220629, PDE 4d inhibitor BHN (Pfizer Inc.); arofylline, LAS-37779 (Almirall Prodesfarma SA.); roflumilast, hydroxypumafentrine (Altana AG), tetomilast (Otska Pharmaceutical Co. Ltd.); tipelukast, ibudilast (Kyorin Pharmaceutical), CC-10004 (Celgene Corp.); HT-0712, IPL-4088 (Inflazyme Pharmaceuticals Ltd.); MEM-1414, MEM-1917 (Memory Pharmaceuticals Corp.); oglemilast, GRC-4039 (Glenmark Pharmaceuticals Ltd.); AWD-12-281, ELB-353, ELB-526 (Elbion AG); EHT-0202 (ExonHit Therapeutics SA.); ND-1251 (Neuro3d SA.); 4AZA-PDE4 (4 AZA Bioscience NV.); AVE-8112 (Sanofi-Aventis); CR-3465 (Rottapharm SpA.); GP-0203, NCS-613 (Centre National de la Recherche Scientifique); KF-19514 (Kyowa Hakko Kogyo Co. Ltd.); ONO-6126 (Ono Pharmaceutical Co. Ltd.); OS-0217 (Dainippon Pharmaceutical Co. Ltd.); IBFB-130011, IBFB-150007, IBFB-130020, IBFB-140301 (IBFB Pharma GmbH); IC-485 (ICOS Corp.); RBx-14016 and RBx-11082 (Ranbaxy Laboratories Ltd.). A preferred PDE-4-inhibitor is Rolipram.

[0117] MAO inhibitors and compositions containing such inhibitors are described, e.g. in W02006/091988, WO2005/007614, WO2004/089351, WO01/26656, WO01/12176, WO99/57120, WO99/57119, WO99/13878, WO98/40102, WO98/01157, WO96/20946, WO94/07890 and WO92/21333.

[0118] Suitable MAO-inhibitors for the purpose of the present invention are for example Linezolid (Pharmacia Corp.); RWJ-416457 (RW Johnson Pharmaceutical Research Institute); budipine (Altana AG); GPX-325 (BioResearch Ireland); isocarboxazid; phenelzine; tranylcypromine; indantadol (Chiesi Farmaceutici SpA.); moclobemide (Roche Holding AG); SL-25.1131 (Sanofi-Synthelabo); CX-1370 (Burroughs Wellcome Co.); CX-157 (Krenitsky Pharmaceuticals Inc.); desoxypeganine (HF Arzneimittelforschung GmbH & Co. KG); bifemelane (Mitsubishi-Tokyo Pharmaceuticals Inc.); RS-1636 (Sankyo Co. Ltd.); esuprone (BASF AG); rasagiline (Teva Pharmaceutical Industries Ltd.); ladostigil (Hebrew University of Jerusalem); safinamide (Pfizer) and NW-1048 (Newron Pharmaceuticals SpA.).

[0119] Suitable histamine H3 antagonists for the purpose of the present invention are, e.g. ABT-239, ABT-834 (Abbott

Laboratories); 3874-H1 (Aventis Pharma); UCL-2173 (Berlin Free University), UCL-1470 (BioProjet, Societe Civile de Recherche); DWP-302 (Daewoong Pharmaceutical Co Ltd); GSK-189254A, GSK-207040A (GlaxoSmithKline Inc.); cipralisant, GT-2203 (Gliatech Inc.); Ciproxifan (INSERM), 1S,2S)-2-(2-Aminoethyl)-1-(1H-imidazol-4-yl)cyclopropane (Hokkaido University); JNJ-17216498, JNJ-5207852 (Johnson & Johnson); NNC-0038-0000-1049 (Novo Nordisk A/S); and Sch-79687 (Schering-Plough).

[0120] PEP inhibitors and compositions containing such inhibitors are described, e.g. in JP 01042465, JP 03031298, JP 04208299, WO 00/71144, US 5,847,155; JP 09040693, JP 10077300, JP 05331072, JP 05015314, WO 95/15310, WO 93/00361, EP 0556482, JP 06234693, JP 01068396, EP 0709373, US 5,965,556, US 5,756,763, US 6,121,311, JP 63264454, JP 64000069, JP 63162672, EP 0268190, EP 0277588, EP 0275482, US 4,977,180, US 5,091,406, US 4,983,624, US 5,112,847, US 5,100,904, US 5,254,550, US 5,262,431, US 5,340,832, US 4,956,380, EP 0303434, JP 03056486, JP 01143897, JP 1226880, EP 0280956, US 4,857,537, EP 0461677, EP 0345428, JP 02275858, US 5,506,256, JP 06192298, EP 0618193, JP 03255080, EP 0468469, US 5,118,811, JP 05025125, WO 9313065, JP 05201970, WO 9412474, EP 0670309, EP 0451547, JP 06339390, US 5,073,549, US 4,999,349, EP 0268281, US 4,743,616, EP 0232849, EP 0224272, JP 62114978, JP 62114957, US 4,757,083, US 4,810,721, US 5,198,458, US 4,826,870, EP 0201742, EP 0201741, US 4,873,342, EP 0172458, JP 61037764, EP 0201743, US 4,772,587, EP 0372484, US 5,028,604, WO 91/18877, JP 04009367, JP 04235162, US 5,407,950, WO 95/01352, JP 01250370, JP 02207070, US 5,221,752, EP 0468339, JP 04211648, WO 99/46272, WO 2006/058720 and PCT/EP2006/061428.

[0121] Suitable prolyl endopeptidase inhibitors for the purpose of the present invention are, e.g. Fmoc-Ala-Pyrr-CN, Z-Phe-Pro-Benzothiazole (Probiodrug), Z-321 (Zeria Pharmaceutical Co Ltd.); ONO-1603 (Ono Pharmaceutical Co Ltd); JTP-4819 (Japan Tobacco Inc.) and S-17092 (Servier).

[0122] Other suitable compounds that can be used according to the present invention in combination with QC-inhibitors are NPY, an NPY mimetic or an NPY agonist or antagonist or a ligand of the NPY receptors.

[0123] Preferred according to the present invention are antagonists of the NPY receptors.

[0124] Suitable ligands or antagonists of the NPY receptors are 3a, 4,5,9b-tetrahydro-1h-benz[e]indol-2-yl amine-derived compounds as disclosed in WO 00/68197.

[0125] NPY receptor antagonists which may be mentioned include those disclosed in European patent applications EP 0 614 911, EP 0 747 357, EP 0 747 356 and EP 0 747 378; international patent applications WO 94/17035, WO 97/19911, WO 97/19913, WO 96/12489, WO 97/19914, WO 96/22305, WO 96/40660, WO 96/12490, WO 97/09308, WO 97/20820, WO 97/20821, WO 97/20822, WO 97/20823, WO 97/19682, WO 97/25041, WO 97/34843, WO 97/46250, WO 98/03492, WO 98/03493, WO 98/03494 and WO 98/07420; WO 00/30674, US patents Nos. 5,552,411, 5,663,192 and 5,567,714; 6,114,336, Japanese patent application JP 09157253; international patent applications WO 94/00486, WO 93/12139, WO 95/00161 and WO 99/15498; US Patent No. 5,328,899; German patent application DE 393 97 97; European patent applications EP 355 794 and EP 355 793; and Japanese patent applications JP 06116284 and JP 07267988. Preferred NPY antagonists include those compounds that are specifically disclosed in these patent documents. More preferred compounds include amino acid and non-peptide-based NPY antagonists. Amino acid and non-peptide-based NPY antagonists which may be mentioned include those disclosed in European patent applications EP 0 614 911, EP 0 747 357, EP 0 747 356 and EP 0 747 378; international patent applications WO 94/17035, WO 97/19911, WO 97/19913, WO 96/12489, WO 97/19914, WO 96/22305, WO 96/40660, WO 96/12490, WO 97/09308, WO 97/20820, WO 97/20821, WO 97/20822, WO 97/20823, WO 97/19682, WO 97/25041, WO 97/34843, WO 97/46250, WO 98/03492, WO 98/03493, WO 98/03494, WO 98/07420 and WO 99/15498 ; US patents Nos. 5,552,411, 5,663,192 and 5,567,714; and Japanese patent application JP 09157253. Preferred amino acid and non-peptide-based NPY antagonists include those compounds that are specifically disclosed in these patent documents.

[0126] Particularly preferred compounds include amino acid-based NPY antagonists. Amino acid-based compounds, which may be mentioned include those disclosed in international patent applications WO 94/17035, WO 97/19911, WO 97/19913, WO 97/19914 or, preferably, WO 99/15498. Preferred amino acid-based NPY antagonists include those that are specifically disclosed in these patent documents, for example BIBP3226 and, especially, (R)-N2-(diphenylacetyl)-(R)-N-[1-(4-hydroxy- phenyl) ethyl] arginine amide (Example 4 of international patent application WO 99/15498).

[0127] M1 receptor agonists and compositions containing such inhibitors are described, e.g. in W02004/087158, WO91/10664.

[0128] Suitable M1 receptor antagonists for the purpose of the present invention are for example CDD-0102 (Cognitive Pharmaceuticals); Cevimeline (Evoxac) (Snow Brand Milk Products Co. Ltd.); NGX-267 (TorreyPines Therapeutics); sabcomeline (GlaxoSmithKline); alvameline (H Lundbeck A/S); LY-593093 (Eli Lilly & Co.); VRTX-3 (Vertex Pharmaceuticals Inc.); WAY-132983 (Wyeth) and CI-101 7/ (PD-151832) (Pfizer Inc.).

[0129] Acetylcholinesterase inhibitors and compositions containing such inhibitors are described, e.g. in W02006/071274, W02006/070394, W02006/040688, W02005/092009, WO2005/079789, W02005/039580, W02005/027975, W02004/084884, WO2004/037234, WO2004/032929, WO03/101458. WO03/091220, WO03/082820, WO03/020289, WO02/32412, WO01/85145, WO01/78728, WO01/66096, WO00/02549, WO01/00215, WO00/15205, WO00/23057, WO00/33840, WO00/30446, WO00/23057, WO00/15205, WO00/09483, WO00/07600, WO00/02549,

WO99/47131, WO99/07359, WO98/30243, WO97/38993, WO97/13754, WO94/29255, WO94/20476, WO94/19356, WO93/03034 and WO92/19238.

[0130] Suitable acetylcholinesterase inhibitors for the purpose of the present invention are for example Donepezil (Eisai Co. Ltd.); rivastigmine (Novartis AG); (-)-phenserine (TorreyPines Therapeutics); ladostigil (Hebrew University of Jerusalem); huperzine A (Mayo Foundation); galantamine (Johnson & Johnson); Memoquin (Universita di Bologna); SP-004 (Samaritan Pharmaceuticals Inc.); BGC-20-1259 (Sankyo Co. Ltd.); physostigmine (Forest Laboratories Inc.); NP-0361 (Neuropharma SA); ZT-1 (Debiopharm); tacrine (Warner-Lambert Co.); metrifonate (Bayer Corp.) and INM-176 (Whanln).

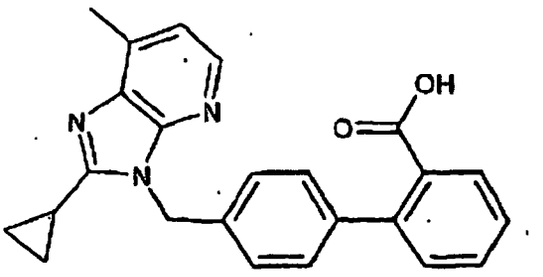
[0131] NMDA receptor antagonists and compositions containing such inhibitors are described, e.g. in WO2006/094674, W02006/058236, WO2006/058059, W02006/010965, WO2005/000216, WO2005/102390, WO2005/079779, WO2005/079756, W02005/072705, WO2005/070429, WO2005/055996, W02005/035522, WO2005/009421, W02005/000216, WO2004/092189, W02004/039371, W02004/028522, WO2004/009062, WO03/010159, WO02/072542, WO02/34718, WO01/98262, WO01/94321, WO01/92204, WO01/81295, WO01/32640, WO01/10833, WO01/10831, WO00/56711, WO00/29023, WO00/00197, WO99/53922, WO99/48891, WO99/45963, WO99/01416, WO99/07413, WO99/01416, WO98/50075, WO98/50044, WO98/10757, WO98/05337, WO97/32873, WO97/23216, WO97/23215, WO97/23214, WO96/14318, WO96/08485, WO95/31986, WO95/26352, WO95/26350, WO95/26349, WO95/26342, WO95/12594, WO95/02602, WO95/02601, WO94/20109, WO94/13641, WO94/09016 and WO93/25534.

[0132] Suitable NMDA receptor antagonists for the purpose of the present invention are for example Memantine (Merz & Co. GmbH); topiramate (Johnson & Johnson); AVP-923 (Neurodex) (Center for Neurologic Study); EN-3231 (Endo Pharmaceuticals Holdings Inc.); neramexane (MRZ-2/579) (Merz and Forest); CNS-5161 (CeNeS Pharmaceuticals Inc.); dexanabinol (HU-211; Sinnabidol; PA-50211) (Pharmos); EpiCept NP-1 (Dalhousie University); indantadol (V-3381; CNP-3381) (Vernalis); perzinfotel (EAA-090, WAY-126090, EAA-129) (Wyeth); RGH-896 (Gedeon Richter Ltd.); traxoprodil (CP-101606), besonprodil (PD-196860, CI-1041) (Pfizer Inc.); CGX-1007 (Cognetix Inc.); delucemine (NPS-1506) (NPS Pharmaceuticals Inc.); EVT-101 (Roche Holding AG); acamprosate (Synchroneuron LLC.); CR-3991, CR-2249, CR-3394 (Rottapharm SpA.); AV-101 (4-Cl-kynurenine (4-Cl-KYN)), 7-chloro-kynurenic acid (7-Cl-KYNA) (VistaGen); NPS-1407 (NPS Pharmaceuticals Inc.); YT-1006 (Yaupon Therapeutics Inc.); ED-1812 (Sosei R&D Ltd.); himantane (hydrochloride N-2-(adamantly)-hexamethylen-imine) (RAMS); Lancicemine (AR-R-15896) (AstraZeneca); EVT-102, Ro-25-6981 and Ro-63-1908 (Hoffmann-La Roche AG / Evotec).

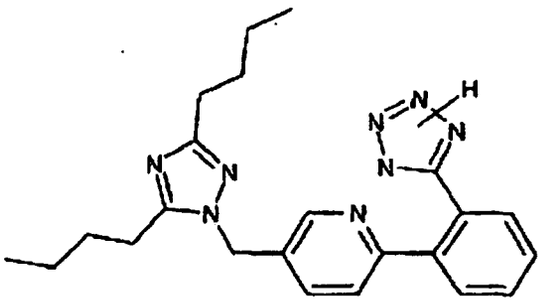
[0133] Furthermore, the present invention relates to combination therapies useful for the treatment of atherosclerosis, restenosis or arthritis, administering a QC inhibitor in combination with another therapeutic agent selected from the group consisting of inhibitors of the angiotensin converting enzyme (ACE); angiotensin II receptor blockers; diuretics; calcium channel blockers (CCB); beta-blockers; platelet aggregation inhibitors; cholesterol absorption modulators; HMG-Co-A reductase inhibitors; high density lipoprotein (HDL) increasing compounds; renin inhibitors; IL-6 inhibitors; antiinflammatory corticosteroids; antiproliferative agents; nitric oxide donors; inhibitors of extracellular matrix synthesis; growth factor or cytokine signal transduction inhibitors; MCP-1 antagonists and tyrosine kinase inhibitors providing beneficial or synergistic therapeutic effects over each monotherapy component alone.

[0134] Angiotensin II receptor blockers are understood to be those active agents that bind to the AT1 - receptor subtype of angiotensin II receptor but do not result in activation of the receptor. As a consequence of the blockade of the AT1 receptor, these antagonists can, e.g. be employed as antihypertensive agents.

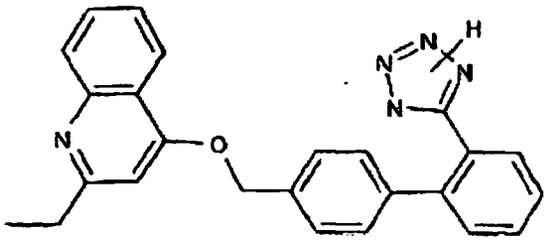
[0135] Suitable angiotensin II receptor blockers which may be employed in the combination of the present invention include AT_1 receptor antagonists having differing structural features, preferred are those with non-peptidic structures. For example, mention may be made of the compounds that are selected from the group consisting of valsartan (EP 443983), losartan (EP 253310), candesartan (EP .459136), eprosartan (EP 403159), irbesartan (EP 454511), olmesartan (EP 503785), tasosartan (EP 539086), telmisartan (EP 522314), the compound with the designation E-41 77 of the formula



the compound with the designation SC-52458 of the following formula



and the compound with the designation the compound ZD-8731 of the formula



or, in each case, a pharmaceutically acceptable salt thereof.

[0136] Preferred AT1-receptor antagonists are those agents that have been approved and reached the market, most preferred is valsartan, or a pharmaceutically acceptable salt thereof.

[0137] The interruption of the enzymatic degradation of angiotensin to angiotensin II with ACE inhibitors is a successful variant for the regulation of blood pressure and thus also makes available a therapeutic method for the treatment of hypertension.

[0138] A suitable ACE inhibitor to be employed in the combination of the present invention is, e.g. a compound selected from the group consisting alacepril, benazepril, benazeprilat; captopril, ceronapril, cilazapril, delapril, enalapril, enaprilat, fosinopril, imidapril, lisinopril, moveltopril, perindopril, quinapril, ramipril, spirapril, temocapril and trandolapril, or in each case, a pharmaceutically acceptable salt thereof.

[0139] Preferred ACE inhibitors are those agents that have been marketed, most preferred are benazepril and enalapril.

[0140] A diuretic is, for example, a thiazide derivative selected from the group consisting of chlorothiazide, hydrochlorothiazide, methylclothiazide, and chlorothalidon. The most preferred diuretic is hydrochlorothiazide. A diuretic furthermore comprises a potassium sparing diuretic such as amiloride or triameterine, or a pharmaceutically acceptable salt thereof.

[0141] The class of CCBs essentially comprises dihydropyridines (DHPs) and non-DHPs, such as diltiazem-type and verapamil-type CCBs.

[0142] A CCB useful in said combination is preferably a DHP representative selected from the group consisting of amlodipine, felodipine, ryosidine, isradipine, lacidipine, nicardipine, nifedipine, niguldipine, niludipine, nimodipine, nisoldipine, nitrendipine and nivaldipine, and is preferably a non-DHP representative selected from the group consisting of flunarizine, prenylamine, diltiazem, fendiline, gallopamil, mibefradil, anipamil, tiapamil and verapamil, and in each case, a pharmaceutically acceptable salt thereof. All these CCBs are therapeutically used, e.g. as antihypertensive, anti-angina pectoris or anti-arrhythmic drugs.

[0143] Preferred CCBs comprise amlodipine, diltiazem, isradipine, nicardipine, nifedipine, nimodipine, nisoldipine, nitrendipine and verapamil or, e.g. dependent on the specific CCB, a pharmaceutically acceptable salt thereof. Especially preferred as DHP is amlodipine or a pharmaceutically acceptable salt thereof, especially the besylate. An especially preferred representative of non-DHPs is verapamil or a pharmaceutically acceptable salt, especially the hydrochloride, thereof.

[0144] Beta-blockers suitable for use in the present invention include beta-adrenergic blocking agents (beta-blockers), which compete with epinephrine for beta-adrenergic receptors and interfere with the action of epinephrine. Preferably, the beta-blockers are selective for the beta-adrenergic receptor as compared to the alpha-adrenergic receptors, and so do not have a significant alpha-blocking effect. Suitable beta-blockers include compounds selected from acebutolol, atenolol, betaxolol, bisoprolol, carteolol, carvedilol, esmolol, labetalol, metoprolol, nadolol, oxprenolol, penbutolol, pindolol, propranolol, sotalol and timolol. Where the beta-blocker is an acid or base or otherwise capable of forming pharmaceutically acceptable salts or prodrugs, these forms are considered to be encompassed herein, and it is understood that the compounds may be administered in free form or in the form of a pharmaceutically acceptable salt or a prodrug,

such as a physiologically hydrolyzable and acceptable ester. For example, metoprolol is suitably administered as its tartrate salt, propranolol is suitably administered as the hydrochloride salt, and so forth.

[0145] Platelet aggregation inhibitors include PLAVIX® (clopidogrel bisulfate), PLETAL® (cilostazol) and aspirin.

[0146] Cholesterol absorption modulators include ZETIA® (ezetimibe) and KT6-971 (Kotobuki Pharmaceutical Co. Japan).

[0147] HMG-Co-A reductase inhibitors (also called beta-hydroxy-beta-methylglutaryl-co-enzyme-A reductase inhibitors or statins) are understood to be those active agents which may be used to lower lipid levels including cholesterol in blood.

[0148] The class of HMG-Co-A reductase inhibitors comprises compounds having differing structural features. For example, mention may be made of the compounds, which are selected from the group consisting of atorvastatin, cerivastatin, fluvastatin, lovastatin, pitavastatin, pravastatin, rosuvastatin and simvastatin, or in each case, a pharmaceutically acceptable salt thereof.

[0149] Preferred HMG-Co-A reductase inhibitors are those agents, which have been marketed, most preferred is atorvastatin, pitavastatin or simvastatin, or a pharmaceutically acceptable salt thereof.

[0150] HDL-increasing compounds include, but are not limited to, cholesterol ester transfer protein (CETP) inhibitors. Examples of CETP inhibitors include JTT7O5 disclosed in Example 26 of U.S. Patent No. 6,426,365 issued July 30, 2002, and pharmaceutically acceptable salts thereof. Inhibition of interleukin 6 mediated inflammation may be achieved indirectly through regulation of endogenous cholesterol synthesis and isoprenoid depletion or by direct inhibition of the signal transduction pathway utilizing interleukin-6 inhibitor/antibody, interleukin-6 receptor inhibitor/antibody, interleukin-6 antisense oligonucleotide (ASON), gp130 protein inhibitor/antibody, tyrosine kinase inhibitors/antibodies, serine/threonine kinase inhibitors/antibodies, mitogen-activated protein (MAP) kinase inhibitors/antibodies, phosphatidylinositol 3-kinase (PI3K) inhibitors/antibodies, Nuclear factor kappaB (NF-κB) inhibitors/antibodies, IκB kinase (IKK) inhibitors/antibodies, activator protein-1 (AP-1) inhibitors/antibodies, STAT transcription factors inhibitors/antibodies, altered IL-6, partial peptides of IL-6 or IL-6 receptor, or SOCS (suppressors of cytokine signaling) protein, PPAR gamma and/or PPAR beta/delta activators/ligands or a functional fragment thereof.

[0151] A suitable antiinflammatory corticosteroid is dexamethasone.

[0152] Suitable antiproliferative agents are cladribine, rapamycin, vincristine and taxol.

[0153] A suitable inhibitor of extracellular matrix synthesis is halofuginone.

[0154] A suitable growth factor or cytokine signal transduction inhibitor is, e.g. the ras inhibitor R115777.

[0155] A suitable tyrosine kinase inhibitor is tyrphostin.

[0156] Suitable renin inhibitors are described, e.g. in WO 2006/116435. A preferred renin inhibitor is aliskiren, preferably in the form of the hemi-fumarate salt thereof.

[0157] MCP-1 antagonists may, e.g. be selected from anti-MCP-1 antibodies, preferably monoclonal or humanized monoclonal antibodies, MCP-1 expression inhibitors, CCR2-antagonists, TNF-alpha inhibitors, VCAM-1 gene expression inhibitors and anti-C5a monoclonal antibodies.

[0158] MCP-1 antagonists and compositions containing such inhibitors are described, e.g. in WO02/070509, WO02/081463, WO02/060900, US2006/670364, US2006/677365, WO2006/097624, US2006/316449, WO2004/056727, WO03/053368, WO00/198289, WO00/157226, WO00/046195, WO00/046196, WO00/046199, WO00/046198, WO00/046197, WO99/046991, WO99/007351, WO98/006703, WO97/012615, WO2005/105133, WO03/037376, W02006/125202, W02006/085961, W02004/024921, WO2006/074265.

[0159] Suitable MCP-1 antagonists are, for instance, C-243 (Telik Inc.); NOX-E36 (Noxxon Pharma AG); AP-761 (Actimis Pharmaceuticals Inc.); ABN-912, NIBR-177 (Novartis AG); CC-11006 (Celgene Corp.); SSR-150106 (Sanofi-Aventis); MLN-1202 (Millenium Pharmaceuticals Inc.); AGI-1067, AGIX-4207, AGI-1096 (AtherioGenics Inc.); PRS-211095, PRS-211092 (Pharmos Corp.); anti-C5a monoclonal antibodies, e.g. neutrazumab (G2 Therapies Ltd.); AZD-6942 (AstraZeneca plc.); 2-mercaptoimidazoles (Johnson & Johnson); TEI-E00526, TEI-6122 (Deltagen); RS-504393 (Roche Holding AG); SB-282241, SB-380732, ADR-7 (GlaxoSmithKline); anti-MCP-1 monoclonal antibodies (Johnson & Johnson).

[0160] Combinations of QC-inhibitors with MCP-1 antagonists may be useful for the treatment of inflammatory diseases in general, including neurodegenerative diseases.

[0161] Combinations of QC-inhibitors with MCP-1 antagonists are preferred for the treatment of Alzheimer's disease.

[0162] Most preferably the QC inhibitor is combined with one or more compounds selected from the following group:

PF-4360365, m266, bapineuzumab, R-1450, Posiphen, (+)-phenserine, MK-0752, LY-450139, E-2012, (R)-flurbiprofen, AZD-103, AAB-001 (Bapineuzumab), Tramiprosate, EGb-761, TAK-070, Doxofylline, theophylline, cilomilast, tofimilast, roflumilast, tetomilast, tipelukast, ibudilast, HT-0712, MEM-1414, oglemilast, Linezolid, budipine, isocarboxazid, phenelzine, tranylcypromine, indantadol, moclobemide, rasagiline, ladostigil, safinamide, ABT-239, ABT-834, GSK-189254A, Ciproxifan, JNJ-17216498, Fmoc-Ala-Pyrr-CN, Z-Phe-Pro-Benzothiazole, Z-321, ONO-1603, JTP-4819, S-17092, BIBP3226; (R)-N2-(diphenylacetyl)-(R)-N-[1-(4-hydroxyphenyl) ethyl] arginine amide,

Cevimeline, sabcomeline, (PD-151832), Donepezil, rivastigmine, (-)-phenserine, ladostigil, galantamine, tacrine, metrifonate, Memantine, topiramate, AVP-923, EN-3231, neramexane, valsartan, benazepril, enalapril, hydrochlorothiazide, amlodipine, diltiazem, isradipine, nicardipine, nifedipine, nimodipine, nisoldipine, nitrendipine, verapamil, amlodipine, acebutolol, atenolol, betaxolol, bisoprolol, carteolol, carvedilol, esmolol, labetalol, metoprolol, nadolol, oxprenolol, penbutolol, pindolol, propranolol, sotalol, timolol, PLAVIX® (clopidogrel bisulfate), PLETAL® (cilostazol), aspirin, ZETIA® (ezetimibe) and KT6-971, statins, atorvastatin, pitavastatin or simvastatin; dexamethasone, cladribine, rapamycin, vincristine, taxol, aliskiren, C-243, ABN-912, SSR-150106, MLN-1202 and betaferon.

[0163] In particular, the following combinations are considered:

- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with Atorvastatin for the treatment and/or prevention of artherosclerosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with immunosuppressive agents, preferably rapamycin for the prevention and/or treatment of restenosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with immunosuppressive agents, preferably paclitaxel for the prevention and/or treatment of restenosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with AChE inhibitors, preferably Donepezil, for the prevention and/or treatment of Alzheimer's disease,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with interferones, preferably Aronex, for the prevention and/or treatment of multiple sclerosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with interferones, preferably betaferon, for the prevention and/or treatment of multiple sclerosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with interferones, preferably Rebif, for the prevention and/or treatment of multiple sclerosis
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with Copaxone, for the prevention and/or treatment of multiple sclerosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with dexamethasone, for the prevention and/or treatment of restenosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with dexamethasone, for the prevention and/or treatment of atherosclerosis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with dexamethasone, for the prevention and/or treatment of rheumatid arthritis,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with HMG-Co-A-reductase inhibitors, for the prevention and/or treatment of restenosis, wherein the HMG-Co-A-reductase inhibitor is selected from atorvastatin, cerivastatin, fluvastatin, lovastatin, pitavastatin, pravastatin, rosuvastatin and simvastatin,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with HMG-Co-A reductase inhibitors, for the prevention and/or treatment of atherosclerosis wherein the HMG-Co-A-reductase inhibitor is selected from atorvastatin, cerivastatin, fluvastatin, lovastatin, pitavastatin, pravastatin, rosuvastatin and simvastatin,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with HMG-Co-A reductase inhibitors, for the prevention and/or treatment of rheumatoid arthritis wherein the HMG-Co-A-reductase inhibitor is selected from atorvastatin, cerivastatin, fluvastatin, lovastatin, pitavastatin, pravastatin, rosuvastatin and simvastatin,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with amyloid-beta antibodies for the prevention and/or treatment of mild cognitive impairment, wherein the amyloid-beta antibody is Acl-24,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with amyloid-beta antibodies for the prevention and/or treatment of Alzheimer's disease, wherein the amyloid-beta antibody is Acl-24,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with amyloid-beta antibodies for the prevention and/or treatment of neurodegeneration in Down Syndrome, wherein the amyloid-beta antibody is Acl-24,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with beta-secretase inhibitors for the prevention and/or treatment of mild cognitive impairment, wherein the beta-secretase inhibitor is selected from WY-25105, GW-840736X and CTS-21166,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with beta-secretase inhibitors for the prevention and/or treatment of Alzheimer's disease, wherein the beta-secretase inhibitor is selected from WY-25105, GW-840736X and CTS-21166,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with beta-secretase inhibitors for the prevention and/or treatment of neurodegeneration in Down Syndrome, wherein the beta-secretase inhibitor is selected from WY-25105, GW-840736X and CTS-21166,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with gamma-secretase inhibitors for the prevention and/or treatment of mild cognitive impairment, wherein the gamma-secretase inhibitor is selected from

LY-450139, LY-411575 and AN-37124,

- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with gamma-secretase inhibitors for the prevention and/or treatment of Alzheimer's disease, wherein the gamma-secretase inhibitor is selected from LY-450139, LY-411575 and AN-37124,
- a QC inhibitor, in particular QC inhibitor of formula (I), in combination with gamma-secretase inhibitors for the prevention and/or treatment of neurodegeneration in Down Syndrome, wherein the gamma-secretase inhibitor is selected from LY-450139, LY-411575 and AN-37124.

[0164] Such a combination therapy is in particular useful for AD, FAD, FDD and neurodegeneration in Down syndrome as well as atherosclerosis, rheumatoid arthritis, restenosis and pancreatitis.

[0165] Such combination therapies might result in a better therapeutic effect (less proliferation as well as less inflammation, a stimulus for proliferation) than would occur with either agent alone.

[0166] With regard to the specific combination of inhibitors of QC and further compounds it is referred in particular to WO 2004/098625 in this regard, which is incorporated herein by reference.

Pharmaceutical compositions

[0167] To prepare the pharmaceutical compositions of this invention, at least one compound of formula (I) optionally in combination with at least one of the other aforementioned agents can be used as the active ingredient(s). The active ingredient(s) is intimately admixed with a pharmaceutical carrier according to conventional pharmaceutical compounding techniques, which carrier may take a wide variety of forms depending of the form of preparation desired for administration, e.g., oral or parenteral such as intramuscular. In preparing the compositions in oral dosage form, any of the usual pharmaceutical media may be employed. Thus, for liquid oral preparations, such as for example, suspensions, elixirs and solutions, suitable carriers and additives include water, glycols, oils, alcohols, flavoring agents, preservatives, coloring agents and the like; for solid oral preparations such as, for example, powders, capsules, gelcaps and tablets, suitable carriers and additives include starches, sugars, diluents, granulating agents, lubricants, binders, disintegrating agents and the like. Because of their ease in administration, tablets and capsules represent the most advantageous oral dosage unit form, in which case solid pharmaceutical carriers are obviously employed. If desired, tablets may be sugar coated or enteric coated by standard techniques. For parenterals, the carrier will usually comprise sterile water, though other ingredients, for example, for purposes such as aiding solubility or for preservation, may be included.

[0168] Injectable suspensions may also prepared, in which case appropriate liquid carriers, suspending agents and the like may be employed. The pharmaceutical compositions herein will contain, per dosage unit, e.g., tablet, capsule, powder, injection, teaspoonful and the like, an amount of the active ingredient(s) necessary to deliver an effective dose as described above. The pharmaceutical compositions herein will contain, per dosage unit, e.g., tablet, capsule, powder, injection, suppository, teaspoonful and the like, from about 0.03 mg to 100 mg/kg (preferred 0.1 - 30 mg/kg) and may be given at a dosage of from about 0.1 - 300 mg/kg per day (preferred 1 - 50 mg/kg per day) of each active ingredient or combination thereof. The dosages, however, may be varied depending upon the requirement of the patients, the severity of the condition being treated and the compound being employed. The use of either daily administration or post-periodic dosing may be employed.

[0169] Preferably these compositions are in unit dosage forms from such as tablets, pills, capsules, powders, granules, sterile parenteral solutions or suspensions, metered aerosol or liquid sprays, drops, ampoules, autoinjector devices or suppositories; for oral parenteral, intranasal, sublingual or rectal administration, or for administration by inhalation or insufflation. Alternatively, the composition may be presented in a form suitable for once-weekly or once-monthly administration; for example, an insoluble salt of the active compound, such as the decanoate salt, may be adapted to provide a depot preparation for intramuscular injection. For preparing solid compositions such as tablets, the principal active ingredient is mixed with a pharmaceutical carrier, e.g. conventional tableting ingredients such as corn starch, lactose, sucrose, sorbitol, talc, stearic acid, magnesium stearate, dicalcium phosphate or gums, and other pharmaceutical diluents, e.g. water, to form a solid preformulation composition containing a homogeneous mixture of a compound of the present invention, or a pharmaceutically acceptable salt thereof. When referring to these preformulation compositions as homogeneous, it is meant that the active ingredient is dispersed evenly throughout the composition so that the composition may be readily subdivided into equally effective dosage forms such as tablets, pills and capsules. This solid preformulation composition is then subdivided into unit dosage forms of the type described above containing from 0.1 to about 500 mg of each active ingredient or combinations thereof of the present invention.

[0170] The tablets or pills of the compositions of the present invention can be coated or otherwise compounded to provide a dosage form affording the advantage of prolonged action. For example, the tablet or pill can comprise an inner dosage and an outer dosage component, the latter being in the form of an envelope over the former. The two components can be separated by an enteric layer which serves to resist disintegration in the stomach and permits the inner component to pass intact into the duodenum or to be delayed in release. A variety of material can be used for such enteric layers

or coatings, such materials including a number of polymeric acids with such materials as shellac, cetyl alcohol and cellulose acetate.

[0171] This liquid forms in which the compositions of the present invention may be incorporated for administration orally or by injection include, aqueous solutions, suitably flavoured syrups, aqueous or oil suspensions, and flavoured emulsions with edible oils such as cottonseed oil, sesame oil, coconut oil or peanut oil, as well as elixirs and similar pharmaceutical vehicles. Suitable dispersing or suspending agents for aqueous suspensions, include synthetic and natural gums such as tragacanth, acacia, alginate, dextran, sodium carboxymethylcellulose, methylcellulose, polyvinylpyrrolidone or gelatin.

[0172] The pharmaceutical composition may contain between about 0.01 mg and 100 mg, preferably about 5 to 50 mg, of each compound, and may be constituted into any form suitable for the mode of administration selected. Carriers include necessary and inert pharmaceutical excipients, including, but not limited to, binders, suspending agents, lubricants, flavorants, sweeteners, preservatives, dyes, and coatings. Compositions suitable for oral administration include solid forms, such as pills, tablets, caplets, capsules (each including immediate release, timed release and sustained release formulations), granules, and powders, and liquid forms, such as solutions, syrups, elixirs, emulsions, and suspensions. Forms useful for parenteral administration include sterile solutions, emulsions and suspensions.

[0173] Advantageously, compounds of the present invention may be administered in a single daily dose, or the total daily dosage may be administered in divided doses of two, three or four times daily. Furthermore, compounds for the present invention can be administered in intranasal form via topical use of suitable intranasal vehicles, or via transdermal skin patches well known to those of ordinary skill in that art. To be administered in the form of transdermal delivery system, the dosage administration will, of course, be continuous rather than intermittent throughout the dosage regimen.

[0174] For instance, for oral administration in the form of a tablet or capsule, the active drug component can be combined with an oral, non-toxic pharmaceutically acceptable inert carrier such as ethanol, glycerol, water and the like. Moreover, when desired or necessary, suitable binders; lubricants, disintegrating agents and coloring agents can also be incorporated into the mixture. Suitable binders include, without limitation, starch, gelatin, natural sugars such as glucose or betalactose, corn sweeteners, natural and synthetic gums such as acacia, tragacanth or sodium oleate, sodium stearate, magnesium stearate, sodium benzoate, sodium acetate, sodium chloride and the like. Disintegrators include, without limitation, starch, methyl cellulose, agar, bentonite, xanthan gum and the like.

[0175] The liquid forms in suitable flavored suspending or dispersing agents such as the synthetic and natural gums, for example, tragacanth, acacia, methyl-cellulose and the like. For parenteral administration, sterile suspensions and solutions are desired. Isotonic preparations which generally contain suitable preservatives are employed when intravenous administration is desired.

[0176] The compounds or combinations of the present invention can also be administered in the form of liposome delivery systems, such as small unilamellar vesicles, large unilamellar vesicles, and multilamellar vesicles. Liposomes can be formed from a variety of phospholipids, such as cholesterol, stearylamine or phosphatidylcholines.

[0177] Compounds or combinations of the present invention may also be delivered by the use of monoclonal antibodies as individual carriers to which the compound molecules are coupled. The compounds of the present invention may also be coupled with soluble polymers as targetable drug carriers. Such polymers can include polyvinylpyrrolidone, pyran copolymer, polyhydroxypropylmethacrylamidephenol, polyhydroxyethylaspartamid-ephenol, or polyethyl eneoxidepolyllysine substituted with palmitoyl residue. Furthermore, the compounds of the present invention may be coupled to a class of biodegradable polymers useful in achieving controlled release of a drug, for example, polyactic acid, polyepsilon caprolactone, polyhydroxy butyeric acid, polyorthoesters, polyacetals, polydihydropyrans, polycyanoacrylates and crosslinked or amphipathic block copolymers of hydrogels.

[0178] Compounds or combinations of this invention may be administered in any of the foregoing compositions and according to dosage regimens established in the art whenever treatment of the addressed disorders is required.

[0179] The daily dosage of the products may be varied over a wide range from 0.01 to 1.000 mg per mammal per day. For oral administration, the compositions are preferably provided in the form of tablets containing, 0.01, 0.05, 0.1, 0.5, 1.0, 2.5, 5.0, 10.0, 15.0, 25.0, 50.0, 100, 150, 200, 250 and 500 milligrams of each active ingredient or combinations thereof for the symptomatic adjustment of the dosage to the patient to be treated. An effective amount of the drug is ordinarily supplied at a dosage level of from about 0.1 mg/kg to about 300 mg/kg of body weight per day. Preferably, the range is from about 1 to about 50 mg/kg of body weight per day. The compounds or combinations may be administered on a regimen of 1 to 4 times per day.

[0180] Optimal dosages to be administered may be readily determined by those skilled in the art, and will vary with the particular compound used, the mode of administration, the strength of the preparation, the mode of administration, and the advancement of disease condition. In addition, factors associated with the particular patient being treated, including patient age, weight, diet and time of administration, will result in the need to adjust dosages.

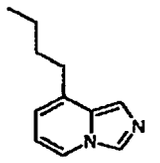
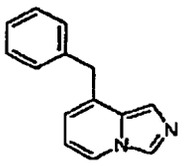
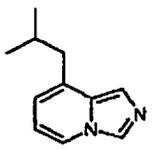
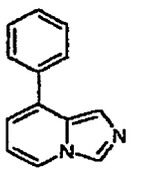
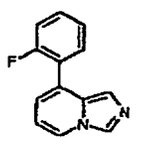
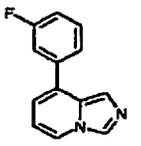
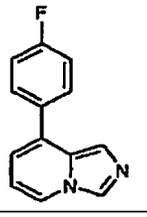
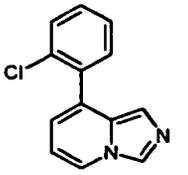
[0181] In a further aspect, the invention also provides a process for preparing a pharmaceutical composition comprising at least one compound of formula (I), optionally in combination with at least one of the other aforementioned agents and a pharmaceutically acceptable carrier.

[0182] The compositions are preferably in a unit dosage form in an amount appropriate for the relevant daily dosage.

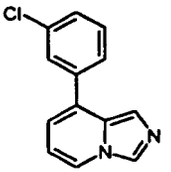
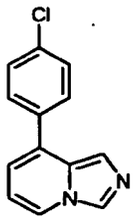
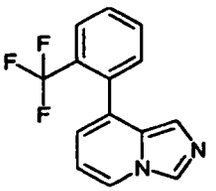
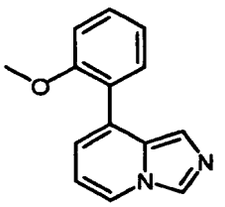
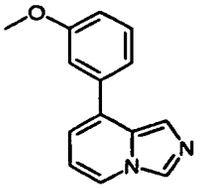
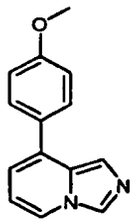
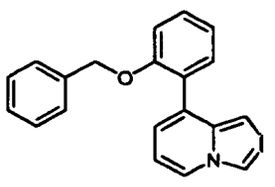
[0183] Suitable dosages, including especially unit dosages, of the the compounds of the present invention include the known dosages including unit doses for these compounds as described or referred to in reference text such as the British and US Pharmacopoeias, Remington's Pharmaceutical Sciences (Mack Publishing Co.), Martindale The Extra Pharmacopoeia (London, The Pharmaceutical Press) (for example see the 31st Edition page 341 and pages cited therein) or the above mentioned publications.

Examples

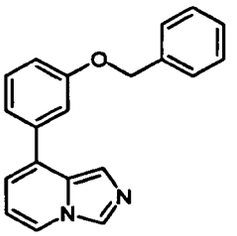
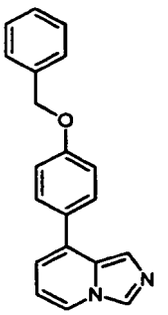
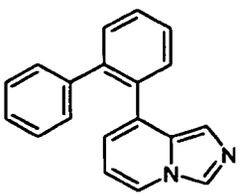
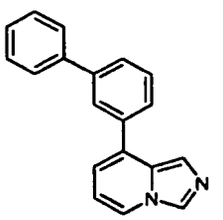
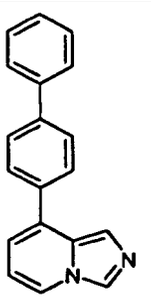
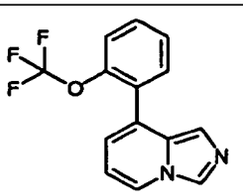
[0184]

Ex.	Name	Structure	MolWeight	Det $[M+H]^+$	K_i	IC_{50}
1	8-butyl*H*-imidazo[1,5-a]pyridine		174.24226	175.1	3.7	13.2
2	8-benzyl*H*-imidazo [1,5-a]pyridine		208.25848	209.1	5.5	18.9
3	8-isobutyl*H*-imidazo [1,5-a]pyridine		174.24226	175.1	3.7	20
4	8-phenyl*H*-imidazo [1,5-a]pyridine		194.23	195.1	1.3	8.22
5	8-(2-fluorophenyl) *H*-imidazo[1,5-a] pyridine		212.22236	213.2	3.14	20.6
6	8-(3-fluorophenyl) *H*-imidazo[1,5-a] pyridine		212.22236	213.2	2.02	9.71
7	8-(4-fluorophenyl) *H*-imidazo[1,5-a] pyridine		212.22236	213.2	1.87	10.6
8	8-(2-chlorophenyl)H-imidazo[1,5-a]pyridine		228.67696	229.4; 231.3 (isotope)	15.2	47.7

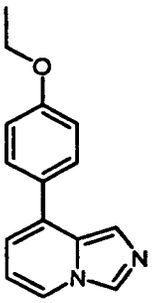
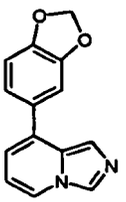
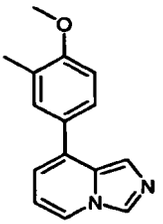
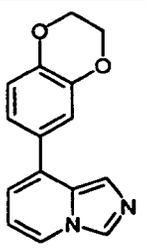
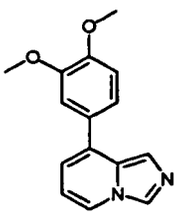
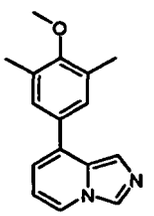
(continued)

Ex.	Name	Structure	MolWeight	Det $[M+H]^+$	K_i	IC_{50}
9	8-(3-chlorophenyl*)* *H*-imidazo[1,5-a] pyridine		228.67696	229.4; 231.4 (isotope)	2.25	17.2
10	8-(4-chlorophenyl) *H*-imidazo[1,5-a] pyridine		228.67696	229.4; 231.4 (isotope)	1.11	5.51
11	8-(2-(trifluoromethyl) phe nyl)*H*-imidazo[1,5-a]pyridine		262.22986	263.2		
12	8-(2-methoxyphenyl) *H*-imidazo[1,5-a] pyridine		224.25788	225.3	3.98	13.6
13	8-(3-methoxyphenyl) *H*-imidazo[1,5-a] pyridine		224.25788	225.3	1.1	6.19
14	8-(4-methoxyphenyl) *H*-imidazo[1,5-a] pyridine		224.25788	225.3	0.83	4.1
15	8-(2-(benzyloxy) phenyl) *H*-imidazo[1,5-a]pyridine		300.35384	301.5; 210.3 [M-C_7H_7]	5.38	23.6

(continued)

Ex.	Name	Structure	MolWeight	Det $[M+H]^+$	K_i	IC_{50}
16	8-(3-(benzyloxy) phenyl) *H*-imidazo[1,5-a]pyridine		300.35384	301.5	1.48	7.81
17	8-(4-(benzyloxy) phenyl) *H*-imidazo[1,5-a]pyridine		300.35384	301.5	0.75	4.36
18	8-(biphen-2-yl) *H*-imidazo[1,5-a] pyridine		270.32786	271.6	11	36.5
19	8-(biphen-3-yl)*H*-imidazo[1,5-a]pyridine		270.32786	271.6	2.51	10.9
20	8-(biphen-4-yl) *H*-imidazo[1,5-a] pyridine		270.32786	271.6	2.13	20.6
21	8-(2-(trifluoromethoxy) phenyl)*H*-imidazo[1,5-a]pyridine		278.22926	279.4	14.5	36.5

(continued)

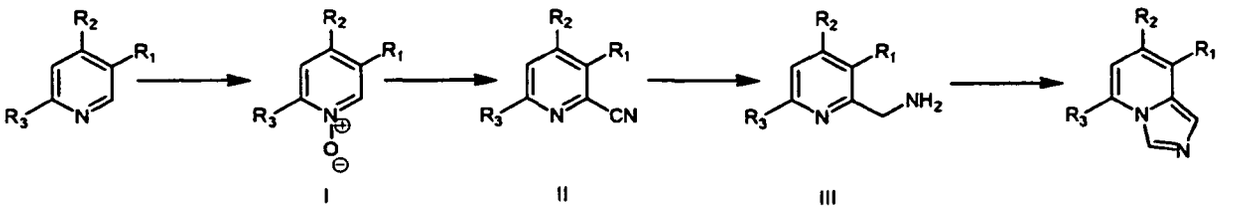
Ex.	Name	Structure	MolWeight	Det $[M+H]^+$	K_i	IC_{50}
22	8-(4-ethoxyphenyl) *H*-imidazo[1,5-a] pyridine		238.28446	239.2	1.89	14.3
23	8-(benzo[d][1,3]dioxo l-6-yl)*H*-imidazo[1,5-a] pyridine		238.2414	239.2	3.46	29.2
24	8-(4-methoxy-3-methylphenyl) *H*-imidazo[1,5-a] pyridine		238.28446	239.2	2.66	26.37
25	8-(2,3-dihydrobenzo[b] [1, 4]dioxin-7-yl) *H*-imidazo[1,5-a] pyridine		252.26798	253.3	1.19	9.17
26	8-(3,4-dimethoxyphenyl) *H*-imidazo[1,5-a] pyridine		254.28386	255.4	9.38	15.4
27	8-(4-methoxy-3,5-dimethylphenyl) *H*-imidazo[1,5-a] pyridine		252.31104	253.3	4.92	27.4

[0185] K_i and IC_{50} values are given in uM.

Synthesis of the examples

Synthesis of the examples 1-4

[0186]



Pyridine-N-oxides (I)

[0187] 1 equivalent (i.e. 80 mmol) of the corresponding pyridine derivative was dissolved in 100 mL of glacial acetic acid and H_2O_2 (30% in water, 9.2mL, 80 mmol, 1eq) was added. The mixture was heated and kept under reflux overnight. After that the solvent was removed. The remaining oil was dissolved in 80mL of CH_2Cl_2 and dried by means of Na_2SO_4. The product was used without further purification.

2-Cyanopyridines (II)

[0188] Trimethylsilylcyanide (10g, 0.1mol, 1.25 eq) were added to a solution of I (80 mmol, 1eq) in 80 mL of CH_2Cl_2. After that a solution of dimethylcarbamoylchloride (10.8 g, 0.1 mol, 1.25 eq). dissolved in 20 mL of dry CH_2Cl_2. was added drop-wise to the stirred solution. The mixture was stirred overnight at r.t. An aqueous solution of K_2CO_3 (80mL, 10%) was added and the mixture was stirred for additional 10 min. The organic layer was separated and the aqueous layer was again extracted two times by means of 30 mL of CH_2Cl_2. The organic phases were combined and dried by means of Na_2SO_4. The product was used without further purification.

2-Aminomethylpyridines (III)

Method A:

[0189] II (2mmol) was dissolved in 40 mL of MeOH and 1mL of conc. HCl were added. After the addition of a palladium catalysator (Pd 10% on charcoal, Pd/C) the mixture was applied to an autoclave an hydrogenated for 6h at a hydrogen pressure of 4 bar. The resulting mixture was filtered through a celite patch and the solvent was evaporated. The resulting product was used without further purification.

Method B:

[0190] 3-Bromo-pyridin-2-nitrile (50 mmol) was dissolved in 100 mL of dry THF. While stirring the solution 250 mL of BH_3-THF complex (1M) was added drop-wise. The mixture was then stirred overnight and 250 mL 2M HCl were added and the solution was refluxed for additionally 30 min. After that a 2M aqueous solution of NaOH (pH-value = 8.0) was added. The mixture was saturated by addition of NaCl. The organic layer was separated and the aqueous solution was again extracted three times by means of 100 mL of THF. The organic layers were combined and dried over Na_2SO_4. After that the solvent was removed and the remaining oil was used without further purification.

Imidazo[1.5-a]pyridines 1-4

[0191] III (5 mmol. 1 eq) was dissolved in 4 mL formic acid and heated under reflux for 3h. The formic acid was removed and the remains were taken up in 100 mL of a saturated $NaHCO_3$-solution. The solution was then extracted three times by means of 10 mL of $CHCl_3$. The organic layers were combined and dried over Na_2SO_4. After the solvent was removed the remains was taken up in 20 mL of toluol and $POCl_3$ (10 mmol. 2 eq). The mixture was kept under reflux for 4h, then the solvent was removed and the remains were taken up in 20 mL of water. After the pH-value of the solution was brought to 10 by means of addition of 1 N NaOH, the aqueous phase was extracted three times by means of 30 mL of $CHCl_3$. After the organic layer was dried, the solvent was evaporated and the remaining oil was purified by flash-chromatography using a $CHCl_3$/MeOH gradient.

Synthesis of 8-bromoH-imidazo[1.5-a]pyridine

3-Bromo-pyridine-N-oxide

[0192] 3-Brompyridine (12.6g, 80.0 mmol) was dissolved in 100 mL of glacial acetic acid and H_2O_2 (30% in water, 9.2mL, 80 mmol, 1 eq) was added. The mixture was heated and kept under reflux overnight. After that the solvent was removed. The remaining oil was dissolved in 80mL of CH_2Cl_2 and dried by means of Na_2SO_4. The product was used without further purification.

3-Bromo-pyridin-2-nitrile

[0193] Trimethylsilylcyanide (10g, 0.1mol, 1.25 eq) were added to a solution of 3-brom-pyridine-N-oxide (80 mmol, 1eq) in 80 mL of CH_2Cl_2. After that a solution of dimethylcarbamoylchloride (10,8 g, 0.1 mol, 1.25 eq). dissolved in 20 mL of dry CH_2Cl_2 was added drop-wise to the stirred solution. The mixture was stirred overnight at r.t. An aqueous solution of K_2CO_3 (80mL, 10%) was added and the mixture was stirred for additional 10 min. The organic layer was separated and the aqueous layer was again extracted two times by means of 30 mL of CH_2Cl_2. The organic phases were combined and dried by means of Na_2SO_4. The product was used without further purification.

2-Aminomethyl-3-bromo pyridine

[0194] 3-Bromo-pyridin-2-nitrile (14.3g, 78.0 mmol) was dissolved in 200 mL of dry THF. While stirring the solution, 100 mL of BH_3-THF complex (1M) (5 eq) was added drop-wise. The mixture was then stirred overnight and 250 mL 4N HCl were added and the solution was refluxed for additionally 30 min. After that a 2M aqueous solution of NaOH (pH-value = 8.0). The mixture was saturated by addition of NaCl. The organic layer was separated and the aqueous solution was again extracted three times by means of 100 mL THF. The organic layers were combined and dried over Na_2SO_4. After that the solvent was removed and the remaining oil was used without further purification.

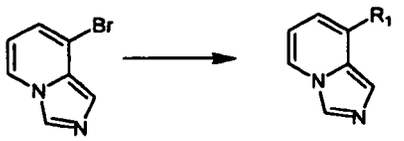
8-Bromo*H*-imidazo[1.5-a]pyridine

[0195] 2-Aminomethyl-3-brom pyridine (14.6g, 78.0 mmol, 1 eq) was dissolved in 20 mL formic acid and heated under reflux for 3h. The formic acid was removed and the remains were taken up in 100 mL of a saturated $NaHCO_3$-solution. The solution was then extracted three times by means of 30 mL of $CHCl_3$. The organic layers were combined and dried over Na_2SO_4. After the solvent was removed the remains was taken up in 40 mL of toluol and $POCl_3$ (12g, 10 mmol, 1 eq). The mixture was kept under reflux for 4h. then the solvent was removed and the remains were taken up in 30 mL of water. After the pH-value of the solution was brought to 10 by means of addition of 1N NaOH. the aqueous phase was extracted three times by means of 30 mL of $CHCl_3$. After the organic layer was dried. the solvent was evaporated and the remaining oil was purified by flash-chromatography using a $CHCl_3$/MeOH gradient.

[0196] Yield over all steps: 2.0 g (13.3%), MS: m/z 196.2 $[M+H]^+$, 198.2 [M+H, isotope]$^+$; HPLC: Method [A], (214 nm), rt: 7.99 min (80.8%).

Synthesis of the examples 5-27

[0197]



Imidazo[1.5-a]pyridines 5-27

[0198] 8-bromo-H-imidazo[1.5-a]pyridine (0.5 mmol, 1 eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), the corresponding boronic acid (0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Column chromatography on neutral alumina eluting with $CHCl_3$/MeOH afforded the pure products.

Semi-preparative HPLC-method

[0199] The system consisted of Merck-Hitachi device (model LaChrom) equipped with a SP250/21 Luna® 100-7 C18 semi-preparative column (Phenomenex. length: 250 mm, diameter: 21 mm). The compounds were purified using a gradient at a flow rate of 6 mL/min; whereby eluent (A) was acetonitrile, eluent (B) was water, both containing 0.1 % (v/v) trifluoro acetic acid applying the following gradient: 0 min - 40 min. 40 -95 % (A)

Examples of the invention

Detailed synthesis description

Example 1: 8-butyl*H*-imidazo[1,5-a]pyridine

[0200] The compound was synthesized starting form 3-butyl-pyridine (0.675 g, 5mmol) as described above.
[0201] Yield over all steps: 15.0 mg (2.0%), ^{1}H-NMR, 400 MHz, $CDCl_3$: δ=0.92-0.96 (m, 3H); 1.35-1.44 (m, 2H); 1.67-1.74 (m, 2H); 2.72-2.76 (m, 2H); 6.47-6.48 (m, 2H); 7.40 (s, 1H); 7.77-7.79 (m, 1H); 8.07 (s, 1H), MS: m/z 175.1 $[M+H]^+$; HPLC: Method [A], (214 nm). rt: 22.45 min (100%)

Example 2: 8-benzyl*H*-imidazo[1,5-a]pyridine

[0202] The compound was synthesized starting form 3-benzyl-pyridine (0.846 g, 5mmol) as described above.
[0203] Yield over all steps: 29.0 mg (3.0%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 4.08 (s, 2H); 6.55 (d, 1H); 6.64 (t, 1H), 7.21-7.31 (m, 5H); 7.41 (s, 1H); 8.04 (d, 1H); 8.72 (s, 1H), MS: m/z 209.1 $[M+H]^+$; HPLC: Method [A], (214 nm), rt: 22.25 min (100%)

Example 3: 8-isobutyl*H*-imidazo[1,5-a]pyridine

[0204] The compound was synthesized starting form 3-isobutyl-pyridine (0.675 g, 5mmol) as described above.
[0205] Yield over all steps: 130.0 mg (15.0%). 1H-NMR, 400MHz, $CDCl_3$: d 0.94 (d, 6H); 2.03-2.15 (m, 1H); 2.59 (d, 2H); 6.43-6.50 (m, 2H); 7.38 (s, 1H); 7.78 (d, 1H); 8.07 (1H)
[0206] MS: m/z 175.1 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 3.89 min (89.9%)

Example 4: 8-phenyl*H*-imidazo[1,5-a]pyridine

[0207] The compound was synthesized starting form 3-phenyl-pyridine (0.775 g, 5mmol) as described above.
[0208] Yield over all steps: 0.023 g (2.4%), ^{1}H-NMR, 400 MHz, $CDCl_3$: δ 6.64 (t, 1H, J=7.06); 6.72-6.74 (m, 1H); 7.42-7.53 (m 4H); 7.66-7.68 (m, 2H); 7.90-7.91 (m, 1H); 8.17 (s, 1H), MS: m/z 196.2 $[M+H]^+$, HPLC: Method [B], (214 nm), rt: 22.16 min (80.8%).

Example 5: 8-(2-fluorophenyl)*H*-imidazo[1,5-a]pyridine

[0209] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g. 0.5 mmol. 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 2-fluorophenyl boronic acid (0.105 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.
[0210] Yield: 0.031 g (30%), ^{1}H-NMR, 500 MHz, $CDCl_3$: δ 6.95-6.97 (m, 1H); 7.01-7.02 (m, 1H); 7.18-7.26 (m, 2H); 7.41-7.47 (m, 2H); 7.508-7.511 (m, 1H); 8.12-8.14 (m, 1H); 0.01 (s, 1H) MS: m/z 213.2 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 4.21 min (94.3%)

Example 6: 8-(3-fluorophenyl)*H*-imidazo[1,5-a]pyridine

[0211] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 3-fluorophenyl boronic acid (0.105 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography

afforded the pure product.

[0212] Yield: 0.026 g (24%), ^{1}H-NMR, 500 MHz, $CDCl_3$: δ 6.98-7.04 (m, 2H); 7.18-7.22 (m, 1H); 7.29-7.32 (m, 1H); 7.40-7.42 (m, 1H); 7.48-7.52 (m, 1H); 7.74 (s, 1H); 8.16 (d, 1H); 9.05 (s, 1H), MS: m/z 213.2 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 4.54 min (94.5%)

Example 7: 8-(4-fluorophenyl)*H*-imidazo[1,5-a]pyridine

[0213] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 4-fluorophenyl boronic acid (0.105 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0214] Yield: 0.023 g (22%), ^{1}H-NMR, 500 MHz, $CDCl_3$: δ 6.97-6.98 (m, 2H); 7.20-7.24 (m, 2H); 7.58-7.61 (m, 2H); 7.70 (s, 1H); 8.11-8.14 (m, 1H); 9.0 (s, 1H), MS: m/z 213.2 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 4.53 min (93.4%)

Example 8: 8-(2-chlorophenyl)*H*-imidazo[1,5-a]pyridine

[0215] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 2-chlorophenyl boronic acid (0.117 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0216] Yield: 0.034 g (30%), ^{1}H-NMR, 500 MHz, $CDCl_3$: δ 6.93-6.98 (m, 2H); 7.33-7.39 (m, 4H); 7.49-7.51 (m, 1H); 8.14-8.16 (m, 1H); 9.04 (s, 1H), MS: m/z 229.4 $[M+H]^+$ 231.3 $[M+H]^+$(isotope), HPLC: Method [B], (214 nm), rt: 5.49 min (93.6%)

Example 9: 8-(3-chlorophenyl)H-imidazo[1,5-a]pyridine

[0217] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 3-chlorophenyl boronic acid (0.117 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0218] Yield: 0.026 g (24%), ^{1}H-NMR, 500 MHz, $CDCl_3$: δ 6.92-6.97 (m, 2H); 7.39-7.47 (m, 3H); 7.53-7.54 (m, 1H); 7.663 (s, 1H); 8.10-8.12 (m, 1H); 8.99 (s, 1H), MS: m/z 229.4 $[M+ H]^+$ 231.3 $[M+H]^+$(isotope); HPLC: Method [B], (214 nm), rt: 6.36 min (93.5%)

Example 10: 8-(4-chlorophenyl)*H*-imidazo[1,5-a]pyridine

[0219] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 4-chlorophenyl boronic acid (0.117 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0220] Yield: 0.008 g (7%), ^{1}H-NMR, 500 MHz, $CDCl_3$: δ 6.93-6.95 (m, 2H); 7.44-7.46 (m, 2H); 7.49-7.51 (m, 2H); 7.66 (s, 1H); 8.09-8.10 (m, 1H); 9.00 (s, 1H), MS: m/z 229.4 $[M+H]^+$ 231.3 $[M+H]^+$(isotope); HPLC: Method [B], (214 nm), rt: 6.61 min (94.6%)

Example 11: 8-(2-(trifluoromethyl)phenyl)H-imidazo[1,5-a]pyridine

[0221] 8-bromo-*H*-imidazo[1,5-a]pyridine (example 12) (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 2-(trifluoromethyl)phenyl)boronic acid (0.142 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with

$CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0222] Yield: 0.009 g (7%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 6.97-6.98 (m, 1H): 7.05 (bs, 1H); 7.27 (bs, 1H); 7.41-7.42 (m, 1H); 7.61-7.67 (2H); 7.84-7.85 (m, 1H)8.41 (bs, 1H); 9.55 (bs, 1H)

[0223] MS: m/z 263.2 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 6.80 min (86.6%)

Example 12: 8-(2-methoxyphenyl)*H*-imidazo[1,5-a]pyridine

[0224] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 2-methoxyphenyl boronic acid (0.114 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0225] Yield: 0.061 g (55%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 3.73 (s, 3H); 6.95-7.04 (m, 4H); 7.28-7.30 (m, 1H); 7.38-7.43 (m, 2H); 8.10-8.12 (m, 1H); 9.07 (s, 1H), MS: m/z 225.3 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 4.24 min (97%)

Example 13: 8-(3-methoxyphenyl)*H*-imidazo[1,5-a]pyridine

[0226] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 3-methoxyphenyl boronic acid (0.114 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0227] Yield: 0.011 g (11%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 3.86 (s, 3H); 6.99-7.05 (m, 3H); 7.11-7.12 (m, 1H); 7.17-7.19 (m, 1H); 7.43 (t, 1H); 7.76 (s, 1H), 8.15 (d, 1H); 9.10 (s, 1H), MS: m/z 225.3 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 4.77 min (97.7%)

Example 14: 8-(4-methoxyphenyl)*H*-imidazo[1,5-a]pyridine

[0228] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 4-methoxyphenyl boronic acid (0.114 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0229] Yield: 0.026 g (24%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 3.88 (s, 3H), 6.99-7.00 (m, 2H); 7.03-7.05 (m, 2H), 7.54-7.56 (m, 2H); 7.76 (s, 1H); 8.11-8.13 (m, 1H); 9.10 (s, 1H), MS: m/z 225.3 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt 4.63 min (91.6%)

Example 15: 8-(2-(benzyloxy)phenyl)*H*-imidazo[1,5-a]pyridine

[0230] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1 eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 2-(benzyloxy)phenyl boronic acid (0.171 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0231] Yield: 0.054 g (37%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 5.07 (s, 2H); 7.02-7.17 (m, 7H); 7.23-7.26 (m, 2H); 7.35-7.37 (m, 1H); 7.42-7.46 (m, 1H); 7.51 (s, 1H); 8.12-8.13 (m, 1H); 9.16 (s, 1H), MS: m/z 301.5 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 9.73 min (94.9%)

Example 16: 8-(3-(benzyloxy)phenyl)*H*-imidazo[1,5-a]pyridine

[0232] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1 eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 3-(benzyloxy)phenyl boronic acid (0.171 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed

for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0233] Yield: 0.021 g (14%). ^{1}H-NMR, 500MHz, $CDCl_3$: δ 5.09 (s, 2H), 6.99-7.03 (m, 2H); 7.06-7.12 (m, 3H); 7.31-7.40 (6H); 7.49 (s, 1H); 8.09 (d, 1H); 9.19 (s, 1H), MS: m/z 301.5 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 10.19 min (92.9%)

Example 17: 8-(4-(benzyloxy)phenyl)*H*-imidazo[1,5-a]pyridine

[0234] 8-bromo-*H*-imidazo[1,5-a]pyridine (example 12) (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 4-(benzyloxy)phenyl boronic acid (0.171 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0235] Yield: 0.044 g (30%), ^{1}H-NMR, 500 MHz, $CDCl_3$: δ 5.09 (2H); 6.93-6.95 (m, 2H); 7.01-7.07 (m, 2H); 7.28-7.41 (m, 5H); 7.48-7.50 (m, 2H); 7.71 (s, 1H); 8.01-8.03 (m, 1H); 8.96 (s, 1H) MS: m/z 301.5 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 10.65 min (100%)

Example 18: 8-(biphen-2-yl)*H*-imidazo[1,5-a]pyridine

[0236] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), biphen-2-yl boronic acid (0.149 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0237] Yield: 0.018 g (13%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 6.76 (dd, 1H); 6.85 (t, 1H); 7.06-7.13 (m, 5H); 7.24-7.25 (m, 1H), 7.39-7.53 (m, 4H); 8.02 (td, 1H); 9.13 (d, 1H),MS: m/z 271.6 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 8.99 min (99.7%)

Example 19: 8-(biphen-3-yl)*H*-imidazo[1,5-a]pyridine

[0238] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), biphen-3-yl boronic acid (0.149 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0239] Yield: 0.015 g (12%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 7.11 (t, 1H); 7.16 (dd, 1H); 7.38-7.41 (m, 1H); 7.46-7.49 (m, 2H); 7.56-7.63 (m, 4H); 7.73 (td, 1H) 7.78-7.79 (m, 1H); 7.84-7.85 (m, 1H); 8.17-8.18 (m, 1H); 9.29 (d, 1H), MS: m/z 271.6 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 9.97 min (86.4%)

Example 20: 8-(biphen-4-yl)*H*-imidazo[1,5-a]pyridine

[0240] 8-bromo*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), biphen-4-yl boronic acid (0.149 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0241] Yield: 0.029 g (22%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 7.01 (t, 1H), 7.06-7.08 (m, 1H); 7.41-7.45 (m, 2H); 7.58-7.64 (m, 5H); 7.69-7.71 (m, 2H); 7.80 (s, 1H); 8.09-8.10 (m, 1H); 9.10 (d, 1H) MS: m/z 271.6 $[M+H]^+$; HPLC: Method [B]. (214 nm), rt: 10.21 min (96.5%)

Example 21: 8-(2-(trifluoromethoxy)phenyl)*H*-imidazo[1,5-a]pyridine

[0242] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 2-(trifluoromethoxy)phenyl boronic acid (0.154 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was

refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0243] Yield: 0.022 g (16%), 1H-NMR, 500MHz, $CDCl_3$: δ 6.99-7.00 (m, 2H); 7.38-7.52 (m, 5H), 8.13-8.15 (m, 1H); 9.09 (s, 1H), MS: m/z 279.4 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 7.24 min (93.5%)

Example 22: 8-(4-ethoxyphenyl)*H*-imidazo[1,5-a]pyridine

[0244] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 4-ethoxyphenyl phenyl boronic acid (0.124 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0245] Yield: 0.017 g (14%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 1.46 (t, 3H); 4.11 (q, 2H); 7.02-7.04 (m, 2H); 7.09-7.11 (m, 2H); 7.50-7.52 (m, 2H); 7.87 (s, 1H); 8.29 (s, 1H); 9.51 (s, 1H), MS: m/z 239.2 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 6.29 min (75.1%)

Example 23: 8-(benzo[d][1,3]dioxol-6-yl)*H*-imidazo[1,5-a]pyridine

[0246] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), benzo[d][1,3]dioxol-6-yl boronic acid (0.124 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0247] Yield: 0.013 g (11%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 6.07 (s, 2H); 6.95-6.96 (m, 1H); 7.02-7.03 (m, 1H); 7.07-7.13 (m, 3H), 7.87 (s, 1H); 8.24 (bs, 1H); 9.41 (bs, 1H), MS: m/z 239.2 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 3.66 min (86.6%)

Example 24: 8-(4-methoxy-3-methylphenyl)*H*-imidazo[1,5-a]pyridine

[0248] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 4-methoxy-3-methylphenyl boronic acid (0.124 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0249] Yield: 0.020 g (17%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 2.29 (s, 3H); 3.90 (s, 3H); 6.94-6.96 (m, 1H); 7.08-7.10 (m, 2H); 7.35 (s, 1H); 7.39-7.41)m, 1H); 7.88 (s, 1H); 8.29 (bs, 1H); 9.52 (bs, 1H), MS: m/z 239.2 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 6.68 min (88.3%)

Example 25: 8-(2,3-dihydrobenzo[b][1,4]dioxin-7-yl)*H*-imidazo[1,5-a]pyridine

[0250] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 2,3-dihydrobenzo[b][1,4]dioxin-7-yl boronic acid (0.135 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0251] Yield: 0.017 g (14%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 4.26-4.32 (m, 4H); 6.93-6.97 (m, 1H); 7.02-7.03 (m, 1H); 7.07-7.13 (m, 3H), 7.87 (s, 1H); 8.24 (bs, 1H); 9.41 (bs, 1H), MS: m/z 253.3 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 4.03 min (87.6%)

Example 26: 8-(3,4-dimethoxyphenyl)*H*-imidazo[1,5-a]pyridine

[0252] 8-bromo-*H*-imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 3,4-dimethoxyphenyl boronic acid (0.136 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed

for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0253] Yield: 0.022 g (18%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 3.76 (m, 6H); 6.93-6.97 (m, 1H); 7.02-7.03 (m, 1H); 7.07-7.13 (m, 3H), 7.87 (s, 1H); 8.24 (bs, 1H); 9.41 (bs, 1H), MS: m/z 255.4 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 2.77 min (91.5%)

Example 27: 8-(4-methoxy-3,5-dimethylphenyl)*H*-imidazo[1,5-a]pyridine

[0254] 8-bromo-*H*- imidazo[1,5-a]pyridine (0.1 g, 0.5 mmol, 1eq) was dissolved in 10 mL of DME and kept under an argon atmosphere. To that solution $[Pd(PPh_3)_4]$ (0.025mmol, 0.05 eq), 4-methoxy-3,5-dimethylphenyl boronic acid (0.135 g, 0.75 mmol, 1.5 eq) and an aqueous NaOH solution (0.2M, 5mL) were added under stirring. The resulting mixture was refluxed for 24h. After cooling, the mixture was diluted with water and the aqueous layer was extracted with $CHCl_3$. The organic layers were dried (Na_2SO_4), filtered and evaporated under reduced pressure. Semi-preparative HPLC-chromatography afforded the pure product.

[0255] Yield: 0.015 g (12%), ^{1}H-NMR, 500MHz, $CDCl_3$: δ 2.36 (s, 6H); 3.79 (s, 3H); 7.08-7.10 (m, 2H); 7.25 (s, 2H); ; 7.88 (s, 1H); 8.29 (bs, 1H); 9.52 (bs, 1H), MS: m/z 253.3 $[M+H]^+$; HPLC: Method [B], (214 nm), rt: 2.77 min (91.5%)

Analytical methods

[0256] The analytical HPLC-system consisted of a Merck-Hitachi device (model LaChrom®) utilizing a Li-Chrospher® 100 RP 18 (5 μm). analytical column (length: 125 mm, diameter: 4 mm). and a diode array detector (DAD) with λ = 214 nm as the reporting wavelength. The compounds were analyzed using a gradient at a flow rate of 1 mL/min; whereby eluent (A) was acetonitrile, eluent (B) was water, both containing 0.1 % (v/v) trifluoro acetic acid applying the following gradient: Method [A]:0 min - 5 min, 5 % (A); 5 min - 17 min, 5 - 15 % (A); 17 min - 29 min, 15 -95 % (A); 29 min - 32 min, 95 % (A); 32 min - 33 min, 95 - 5 % (A); 33 min - 38 min, 5 % (A); Method [B]: 0 min - 25 min, 20 -80 % (A); 25 min - 30 min, 80 -95 % (A); 30 min - 31 min, 95 - 20 % (A); 31 min - 40 min 20 % (A). The purities of all reported compounds were determined by the percentage of the peak area at 214 nm.

[0257] ESI-Mass spectra were obtained with a SCIEX API 365 spectrometer (Perkin Elmer) utilizing the positive ionization mode.

Activity screening

Fluorometric assays

[0258] All measurements were performed with a BioAssay Reader HTS-7000Plus for microplates (Perkin Elmer) at 30 ˚C. QC activity was evaluated fluorometrically using H-Gln-βNA. The samples consisted of 0.2 mM fluorogenic substrate, 0.25 U pyroglutamyl aminopeptidase (Unizyme, Hørsholm, Denmark) in 0.2 M Tris/HCl, pH 8.0 containing 20 mM EDTA and an appropriately diluted aliquot of QC in a final volume of 250 μl. Excitation/emission wavelengths were 320/410 nm. The assay reactions were initiated by addition of glutaminyl cyclase. QC activity was determined from a standard curve of β-naphthylamine under assay conditions. One unit is defined as the amount of QC catalyzing the formation of 1 μmol pGlu-βNA from H-Gln-βNA per minute under the described conditions.

[0259] In a second fluorometric assay, QC was activity determined using H-Gln-AMC as substrate. Reactions were carried out at 30 ˚C utilizing the NOVOStar reader for microplates (BMG labtechnologies). The samples consisted of varying concentrations of the fluorogenic substrate, 0.1 U pyroglutamyl aminopeptidase (Qiagen) in 0.05 M Tris/HCl, pH 8.0 containing 5 mM EDTA and an appropriately diluted aliquot of QC in a final volume of 250 μl. Excitation/emission wavelengths were 380/460 nm. The assay reactions were initiated by addition of glutaminyl cyclase. QC activity was determined from a standard curve of 7-amino-4-methylcoumarin under assay conditions. The kinetic data were evaluated using GraFit sofware.

Spectrophotometric assay of QC

[0260] This novel assay was used to determine the kinetic parameters for most of the QC substrates. QC activity was analyzed spectrophotometrically using a continuous method, that was derived by adapting a previous discontinuous assay (Bateman, R. C. J. 1989 J Neurosci Methods 30, 23-28) utilizing glutamate dehydrogenase as auxiliary enzyme. Samples consisted of the respective QC substrate, 0.3 mM NADH, 14 mM α-Ketoglutaric acid and 30 U/ml glutamate dehydrogenase in a final volume of 250 μl. Reactions were started by addition of QC and persued by monitoring of the decrease in absorbance at 340 nm for 8-15 min.

[0261] The initial velocities were evaluated and the enzymatic activity was determined from a standard curve of

ammonia under assay conditions. All samples were measured at 30 ˚C, using either the SPECTRAFluor Plus or the Sunrise (both from TECAN) reader for microplates. Kinetic data was evaluated using GraFit software.

Inhibitor assay

[0262] For inhibitor testing, the sample composition was the same as described above, except of the putative inhibitory compound added. For a rapid test of QC-inhibition, samples contained 4 mM of the respective inhibitor and a substrate concentration at 1 K_M. For detailed investigations of the inhibition and determination of K_i-values, influence of the inhibitor on the auxiliary enzymes was investigated first. In every case, there was no influence on either enzyme detected, thus enabling the reliable determination of the QC inhibition. The inhibitory constant was evaluated by fitting the set of progress curves to the general equation for competitive inhibition using GraFit software.

MALDI-TOF mass spectrometry

[0263] Matrix-assisted laser desorption/ionization mass spectrometry was carried out using the Hewlett-Packard G2025 LD-TOF System with a linear time of flight analyzer. The instrument was equipped with a 337 nm nitrogen laser, a potential acceleration source (5 kV) and a 1.0 m flight tube. Detector operation was in the positive-ion mode and signals are recorded and filtered using LeCroy 9350M digital storage oscilloscope linked to a personal computer. Samples (5 μl) were mixed with equal volumes of the matrix solution. For matrix solution DHAP/DAHC was used, prepared by solving 30 mg 2',6'-dihydroxyacetophenone (Aldrich) and 44 mg diammonium hydrogen citrate (Fluka) in 1 ml acetonitrile/ 0.1% TFA in water (1/1, v/v). A small volume (≈ 1 μl) of the matrix-analyte-mixture was transferred to a probe tip and immediately evaporated in a vacuum chamber (Hewlett-Packard G2024A sample prep accessory) to ensure rapid and homogeneous sample crystallization.

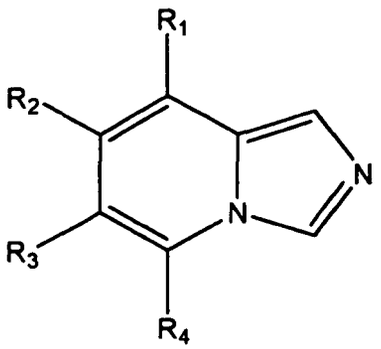
[0264] For long-term testing of Glu^1-cyclization, Aβ-derived peptides were incubated in 100μl 0.1 M sodium acetate buffer, pH 5.2 or 0.1 M Bis-Tris buffer, pH 6.5 at 30 ˚C. Peptides were applied in 0.5 mM [Aβ(3-11)a] or 0.15 mM [Aβ (3-21)a] concentrations, and 0.2 U QC is added all 24 hours. In case of Aβ(3-21)a, the assays contained 1 % DMSO. At different times, samples are removed from the assay tube, peptides extracted using ZipTips (Millipore) according to the manufacturer's recommendations, mixed with matrix solution (1:1 v/v) and subsequently the mass spectra recorded. Negative controls either contain no QC or heat deactivated enzyme. For the inhibitor studies the sample composition was the same as described above, with exception of the inhibitory compound added (5 mM or 2 mM of a test compound of the invention).

[0265] The first QC inhibitors were disclosed in WO 2004/098591 and WO 2005/075436. There are no other potent QC inhibitors known in the art. The same holds true for combinations and compositions for the treatment of neuronal diseases comprising QC inhibitors. Compounds and combinations of the invention may have the advantage that they are, for example, more potent, more selective, have fewer side-effects, have better formulation and stability properties, have better pharmacokinetic properties, be more bioavailable, be able to cross blood brain barrier and are more effective in the brain of mammals, are more compatible or effective in combination with other drugs or be more readily synthesized than other compounds of the prior art.

[0266] Throughout the specification and the claims which follow, unless the context requires otherwise, the word 'comprise', and variations such as 'comprises' and 'comprising', will be understood to imply the inclusion of a stated integer, step, group of integers or group of steps but not to the exclusion of any other integer, step, group of integers or group of steps.

Claims

1. A compound of formula (I),



(I)

or a pharmaceutically acceptable salt or solvate thereof, including all tautomers, and stereoisomers thereof wherein:

R^1 represents C_{2-8}alkyl; C_{2-8}alkenyl; -(C_{1-6}alkyl)-C_{6-12}aryl; -(C_{1-6}alkyl)-bicyclic heteroaryl; - C_{6-12}aryl; or -bicyclic heteroaryl;
wherein said -C_{6-12}aryl or -bicyclic heteroaryl groups may be optionally substituted by one or more substituents selected from halogen, C_{1-4}alkyl, C_{1-4}fluoroalkyl, C_{1-4}alkoxy, C_{1-4}fluoroalkoxy, hydroxy, -SO_2(C_{1-4}alkyl), -SO_2N(C_{1-4}alkyl)(C_{1-4}alkyl), -SOC_{1-4}alkyl, -SOC_{3-6}cycloalkyl, -C(O)O(C_{1-4}alkyl), benzyloxy and phenyl;
R^2 represents H;
R^3 represents H; and
R^4 represents H;
wherein -bicyclic heteroaryl denotes a -bicyclic C_{6-12}aryl residue, wherein one or more ring atoms are replaced by heteroatoms selected from N, S and O.

2. A compound according to claim 1 wherein R^1 represents C_{2-8}alkyl, -(C_{1-6}alkyl)-C_{6-12}aryl, - bicyclic heteroaryl or -C_{6-12}aryl.

3. A compound according to claim 1 or claim 2 wherein R^1 represents -(C_{1-6}alkyl)-C_{6-12}aryl in which C_{6-12}aryl may optionally be substituted.

4. A compound according to claim 1 or claim 2 wherein R^1 represents -C_{6-12}aryl in which -C_{6-12}aryl may optionally be substituted.

5. A compound according to claim 4 wherein R^1 represents optionally substituted phenyl.

6. A compound according to claim 1 as defined in any one of examples 1 to 27:

(1) 8-butyl*H*-imidazo[1,5-a]pyridine,
(2) 8-benzyl*H*-imidazo[1,5-a]pyridine,
(3) 8-isobutyl*H*-imidazo[1,5-a]pyridine,
(4) 8-phenyl*H*-imidazo[1,5-a]pyridine,
(5) 8-(2-fluorophenyl)*H*-imidazo[1,5-a]pyridine,
(6) 8-(3-fluorophenyl)*H*-imidazo[1,5-a]pyridine,
(7) 8-(4-fluorophenyl)*H*-imidazo[1,5-a]pyridine,
(8) 8-(2-chlorophenyl)H-imidazo[1,5-a]pyridine,
(9) 8-(3-chlorophenyl)*H*-imidazo[1,5-a]pyridine,
(10) 8-(4-chlorophenyl)*H*-imidazo[1,5-a]pyridine,
(11) 8-(2-(trifluoromethyl)phenyl)*H*-imidazo[1,5-a]pyridine,
(12) 8-(2-methoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(13) 8-(3-methoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(14) 8-(4-methoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(15) 8-(2-(benzyloxy)phenyl)*H*-imidazo[1,5-a]pyridine,
(16) 8-(3-(benzyloxy)phenyl)*H*-imidazo[1,5-a]pyridine,

(17) 8-(4-(benzyloxy)phenyl)*H*-imidazo[1,5-a]pyridine,
(18) 8-(biphen-2-yl)*H*-imidazo[1,5-a]pyridine,
(19) 8-(biphen-3-yl)*H*-imidazo[1,5-a]pyridine,
(20) 8-(biphen-4-yl)*H*-imidazo[1,5-a]pyridine,
(21) 8-(2-(trifluoromethoxy)phenyl)*H*-imidazo[1,5-a]pyridine,
(22) 8-(4-ethoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(23) 8-(benzo[d][1,3]dioxol-6-yl)*H*-imidazo[1,5-a]pyridine,
(24) 8-(4-methoxy-3-methylphenyl)*H*-imidazo[1,5-a]pyridine,
(25) 8-(2,3-dihydrobenzo[b][1,4]dioxin-7-yl)*H*-imidazo[1,5-a]pyridine,
(26) 8-(3,4-dimethoxyphenyl)*H*-imidazo[1,5-a]pyridine, or
(27) 8-(4-methoxy-3,5-dimethylphenyl)*H*-imidazo[1,5-a]pyridine, or a pharmaceutically acceptable salt or solvate of any one thereof.

7. A compound according to claim 1 as defined in any one of examples 1, 2, 3, 4, 6, 7, 9, 10, 12, 13, 14, 16, 19, 22, 25 or 26:

(1) 8-butyl*H*-imidazo[1,5-a]pyridine,
(2) 8-benzyl*H*-imidazo[1,5-a]pyridine,
(3) 8-isobutyl*H*-imidazo[1,5-a]pyridine,
(4) 8-phenyl*H*-imidazo[1,5-a]pyridine,
(6) 8-(3-fluorophenyl)*H*-imidazo[1,5-a]pyridine,
(7) 8-(4-fluorophenyl)*H*-imidazo[1,5-a]pyridine,
(9) 8-(3-chlorophenyl)*H*-imidazo[1,5-a]pyridine,
(10) 8-(4-chlorophenyl)*H*-imidazo[1,5-a]pyridine,
(12) 8-(2-methoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(13) 8-(3-methoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(14) 8-(4-methoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(16) 8-(3-(benzyloxy)phenyl)*H*-imidazo[1,5-a]pyridine,
(19) 8-(biphen-3-yl)*H*-imidazo[1,5-a]pyridine,
(22) 8-(4-ethoxyphenyl)*H*-imidazo[1,5-a]pyridine,
(25) 8-(2,3-dihydrobenzo[b][1,4]dioxin-7-yl)*H*-imidazo[1,5-a]pyridine, or
(26) 8-(3,4-dimethoxyphenyl)*H*-imidazo[1,5-a]pyridine,

or a pharmaceutically acceptable salt or solvate of any one thereof.

8. A compound according to any one of claims 1 to 7 for use as a medicament.

9. A pharmaceutical composition comprising a compound according to any one of claims 1 to 7 optionally in combination with one or more therapeutically acceptable diluents or carriers.

10. The pharmaceutical composition of claim 9, which additionally comprises at least one additional therapeutic agent.

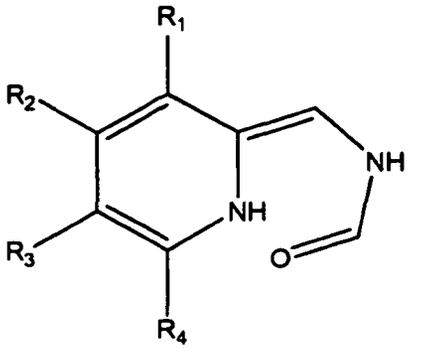
11. A compound according to any one of claims 1 to 7 or a pharmaceutical composition according to claim 9 or claim 10 for use in the treatment of a disease selected from the group consisting of Kennedy's disease, duodenal cancer with or w/o Helicobacter pylori infections, colorectal cancer, Zolliger-Ellison syndrome, gastric cancer with or without Helicobacter pylori infections, pathogenic psychotic conditions, schizophrenia, infertility, neoplasia, inflammatory host responses, cancer, malign metastasis, melanoma, psoriasis, multiple sclerosis, the Guillain-Barré syndrome and chronic inflammatory demyelinizing polyradiculoneuropathy.

12. A compound according to any one of claims 1 to 7 or a pharmaceutical composition according to claim 9 or 10 for use in the treatment of a disease selected from the group consisting of mild cognitive impairment, Alzheimer's disease, Familial British Dementia, Familial Danish Dementia, neurodegeneration in Down Syndrome and Huntington's disease.

13. A compound according to any one of claims 1 to 7 or a pharmaceutical composition according to claim 9 or 10 for use in the treatment of a disease selected from the group consisting of rheumatoid arthritis, atherosclerosis, pancreatitis and restenosis.

14. A process for preparation of a compound of formula (I) according to any one of claims 1 to 7, which comprises ring

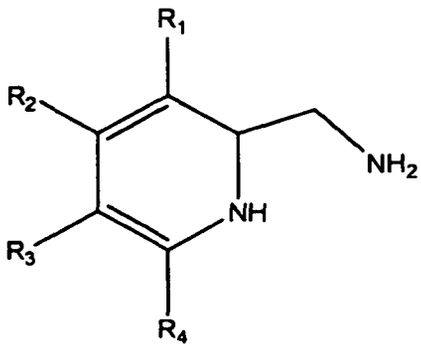
closure reaction of a compound of formula (II)



(II)

or a protected derivative thereof, wherein R^1, R^2, R^3 and R^4 are as defined in any one of claims 1 to 7.

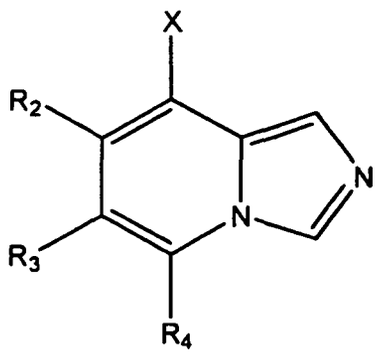
15. A process according to claim 14, wherein the compound of formula (II) is obtained *in situ* by reacting a compound of formula (III)



(III)

or a protected derivative thereof, wherein R^1, R^2, R^3 and R^4 are as defined in any one of claims 1 to 7, with methanoic acid or an activated derivative thereof.

16. A process for preparation of a compound of formula (I) according to any one of claims 1, 2 and 4 to 7 in which R^1 represents optionally substituted -C_{6-12} aryl or -bicyclic heteroaryl, which comprises a cross coupling reaction of a compound of formula (VII)



(VII)

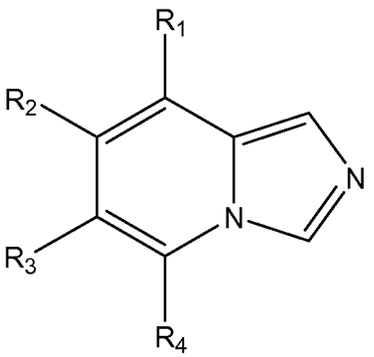
wherein R^2, R^3 and R^4 are as defined in claim 1 and X represents a substituent that is suitable for participation in a cross-coupling reaction
with a compound of formula (VIII)

$$R^1\text{-}Y \qquad \text{(VIII)}$$

wherein R^1 represents optionally substituted -C_{6-12} aryl or -bicyclic heteroaryl and Y represents a boron or tin derivative.

Patentansprüche

1. Verbindung der Formel (I)



(I)

oder ein pharmazeutisch akzeptables Salz oder Solvat davon, inklusive aller Tautomeren und Stereoisomeren davon, wobei
R^1 C_{2-8} Alkyl; C_{2-8} Alkenyl; -(C_{1-6} Alkyl) -C_{6-12} Aryl; - (C_{1-6} Alkyl)-bizyklisches Heteroaryl; -C_{6-12} Aryl; oder - bizyklisches Heteroaryl darstellt;
wobei die -C_{6-12} Aryl oder -bizyklische Heteroaryl Gruppen optional durch ein oder mehrere Substituenten substituiert sein können, die aus Halogen, C_{1-4} Alkyl, C_{1-4} Fluoralkyl, C_{1-4}Alkoxy, C_{1-4} Fluoralkoxy, Hydroxy, -SO_2 (C_{1-4} Alkyl), -SO_2N (C_{1-4} Alkyl) (C_{1-4} Alkyl), -SOC_{1-4} Alkyl, -SOC_{3-6} Cycloalkyl, -C (0) O (C_{1-4} Alkyl), Benzyloxy und Phenyl ausgewählt sind;
R^2 H darstellt;
R^3 H darstellt; und
R^4 H darstellt;
wobei -bizyklisches Heteroaryl einen -bizyklischen C_{6-12} Arylrest bezeichnet, wobei ein oder mehrere Ringatome durch Heteroatome ersetzt sind, die aus N, S und O ausgewählt sind.

2. Verbindung nach Anspruch 1 wobei R^1 C_{2-8} Alkyl, - (C_{1-6} Alkyl) -C_{6-12} Aryl, -bizyklisches Heteroaryl oder -C_{6-12} Aryl darstellt.

3. Verbindung nach Anspruch 1 oder 2 wobei R^1 -(C_{1-6} Alkyl)-C_{6-12} Aryl darstellt, worin C_{6-12} Aryl optional substituiert sein kann.

4. Verbindung nach Anspruch 1 oder Anspruch 2 wobei R^1 -C_{6-12} Aryl darstellt, worin C_{6-12} Aryl optional substituiert sein kann.

5. Verbindung nach Anspruch 4 wobei R^1 optional substituiertes Phenyl darstellt.

6. Verbindung nach Anspruch 1, wie in einem der Beispiele 1 bis 27 definiert:

(1) 8-Butyl-H-imidazo[1,5-a]pyridin,

(2) 8-Benzyl-H-imidazo[1,5-a]pyridin,
(3) 8-Isobutyl-H-imidazo[1,5-a]pyridin,
(4) 8-Phenyl-H-imidazo[1,5-a]pyridin,
(5) 8-(2-Fluorphenyl)-*H*-imidazo[1,5-a]pyridin,
(6) 8-(3-Fluorphenyl)-*H*-imidazo[1,5-a]pyridin,
(7) 8-(4-Fluorphenyl)-*H*-imidazo[1,5-a]pyridin,
(8) 8-(2-Chlorphenyl)-*H*-imidazo[1,5-a]pyridin,
(9) 8-(3-Chlorphenyl)-*H*-imidazo[1,5-a]pyridin,
(10) 8-(4-Chlorphenyl)-*H*-imidazo[1,5-a]pyridin,
(11) 8-(2-(Trifluormethyl)phenyl)-*H*-imidazo[1,5-a]pyridin,
(12) 8-(2-Methoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(13) 8-(3-Methoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(14) 8-(4-Methoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(15) 8-(2-(Benzyloxy)phenyl)-*H*-imidazo[1,5-a]pyridin,
(16) 8-(3-(Benzyloxy)phenyl)-*H*-imidazo[1,5-a]pyridin,
(17) 8-(4-(Benzyloxy)phenyl)-*H*-imidazo[1,5-a]pyridin,
(18) 8-(Biphen-2-yl)-*H*-imidazo[1,5-a]pyridin,
(19) 8-(Biphen-3-yl)-*H*-imidazo[1,5-a]pyridin,
(20) 8-(Biphen-4-yl)-*H*-imidazo[1,5-a]pyridin,
(21) 8-(2-(Trifluormethoxy)phenyl)-*H*-imidazo[1,5-a]pyridin,
(22) 8-(4-Ethoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(23) 8-(Benzo[d][1,3]dioxol-6-yl)-*H*-imidazo[1,5-a]pyridin,
(24) 8-(4-Methoxy-3-methylphenyl)-*H*-imidazo[1,5-a]pyridin,
(25) 8-(2,3-Dihydrobenzo[b][1,4]dioxin-7-yl)-*H*-imidazo[1,5-a]pyridin,
(26) 8-(3,4-Dimethoxyphenyl)-*H*-imidazo[1,5-a]pyridin, oder
(27) 8-(4-Methoxy-3,5-dimethylphenyl)-*H*-imidazo[1,5-a]pyridin,

oder ein pharmazeutisch akzeptables Salz oder Solvat von einer davon.

7. Verbindung nach Anspruch 1, wie in einem der Beispiele 1, 2, 3, 4, 6, 7, 9, 10, 12, 13, 14, 16, 19, 22, 25 oder 26 definiert:

(1) 8-Butyl-*H*-imidazo[1,5-a]pyridin,
(2) 8-Benzyl-*H*-imidazo[1,5-a]pyridin,
(3) 8-Isobutyl-*H*-imidazo[1,5-a]pyridin,
(4) 8-Phenyl-*H*-imidazo[1,5-a]pyridin,
(6) 8-(3-Fluorphenyl)-*H*-imidazo[1,5-a]pyridin,
(7) 8-(4-Fluorphenyl)-*H*-imidazo[1,5-a]pyridin,
(9) 8-(3-Chlorphenyl)-*H*-imidazo[1,5-a]pyridin,
(10) 8-(4-Chlorphenyl)-*H*-imidazo[1,5-a]pyridin,
(12) 8-(2-Methoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(13) 8-(3-Methoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(14) 8-(4-Methoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(16) 8-(3-(Benzyloxy)phenyl)-*H*-imidazo[1,5-a]pyridin,
(19) 8-(Biphen-3-yl)-*H*-imidazo[1,5-a]pyridin,
(22) 8-(4-Ethoxyphenyl)-*H*-imidazo[1,5-a]pyridin,
(25) 8-(2,3-Dihydrobenzo[b][1,4]dioxin-7-yl)-*H*-imidazo[1,5-a]pyridin, oder
(26) 8-(3,4-Dimethoxyphenyl)-*H*-imidazo[1,5-a]pyridin,

oder ein pharmazeutisch akzeptables Salz oder Solvat von einer davon.

8. Verbindung nach einem der Ansprüche 1 bis 7 zur Verwendung als Medikament.

9. Pharmazeutische Zusammensetzung enthaltend eine Verbindung nach einem der Ansprüche 1 bis 7 optional in Kombination mit einem oder mehreren therapeutisch akzeptablen Verdünnungsmitteln oder Trägern.

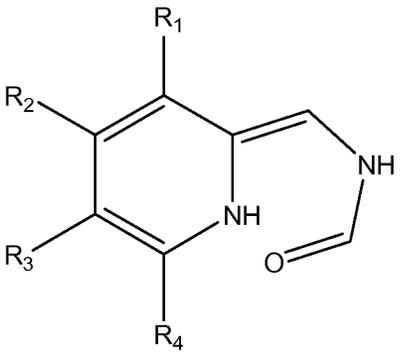
10. Pharmazeutische Zusammensetzung nach Anspruch 9, die zusätzlich zumindest ein weiteres therapeutisches Mittel umfasst.

11. Verbindung nach einem der Ansprüche 1 bis 7 oder pharmazeutische Zusammensetzung nach Anspruch 9 oder Anspruch 10 zur Verwendung bei der Behandlung einer Krankheit, die aus der Gruppe ausgewählt wird, die aus Kennedy-Krankheit (Kennedy's disease), Zwölffingerdarmkrebs mit oder ohne Infektionen mit Helicobacter pylori, Kolorektal-Krebs, Zolliger-Ellison-Syndrom, Magenkrebs mit oder ohne Infektionen mit Helicobacter pylori, pathogenen psychotischen Leiden, Schizophrenie, Unfruchtbarkeit, Gewebsneubildung (Neoplasia), entzündlichen Wirtsantworten (inflammatory host responses), Krebs, maligner Metastase, Melanom, Psoriasis, Multipler Sklerose, dem Guillain-Barre-Syndrom und chronischer entzündlicher entmyelinisierender Polyradiculoneuropathie (chronic inflammatory demyelinizing polyradiculoneuropathy) besteht.

12. Verbindung nach einem der Ansprüche 1 bis 7 oder pharmazeutische Zusammensetzung nach Anspruch 9 oder 10 zur Verwendung bei der Behandlung einer Krankheit, die aus der Gruppe ausgewählt wird, die aus leichter kognitiver Beeinträchtigung (mild cognitive impairment), Alzheimer-Krankheit (Alzheimer's disease), Familial British Dementia, Familial Danish Dementia, Neurodegeneration bei Down-Syndrom und Huntington-Krankheit (Huntington's disease) besteht.

13. Verbindung nach einem der Ansprüche 1 bis 7 oder pharmazeutische Zusammensetzung nach Anspruch 9 oder 10 zur Verwendung bei der Behandlung einer Krankheit, die aus der Gruppe ausgewählt wird, die ausrheumatischer Arthritis, Atherosklerose, Pankreatitis oder Restenose besteht

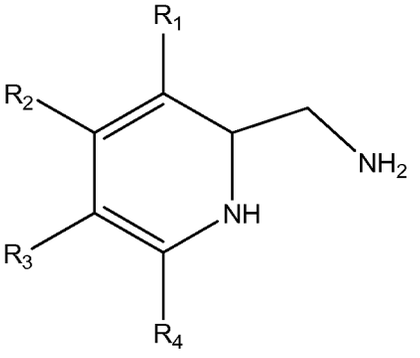
14. Verfahren zur Herstellung einer Verbindung der Formel (I) nach einem der Ansprüche 1 bis 7, umfassend eine Ringschlussreaktion einer Verbindung der Formel (II)



(II)

oder eines geschützten Derivats davon, wobei R^1, R^2, R^3 und R^4 wie in einem der Ansprüche 1 bis 7 definiert sind.

15. Verfahren nach Anspruch 14, wobei die Verbindung der Formel (II) durch Umsetzung einer Verbindung der Formel (III)

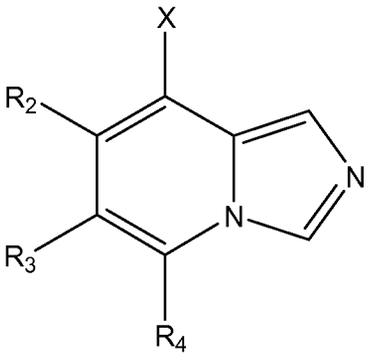


(III)

oder eines geschützten Derivats davon, wobei R^1, R^2, R^3 und R^4 wie in einem der Ansprüche 1 bis 7 definiert sind,

mit Ameisensäure oder einem aktivierten Derivat davon *in situ* erhalten wird.

16. Verfahren zur Herstellung einer Verbindung der Formel (I) nach einem der Ansprüche 1, 2 und 4 bis 7, wobei R^1 optional substituiertes -C_{6-12} Aryl oder -bizyklisches Heteroaryl darstellt, umfassend eine Kreuzkupplungsreaktion einer Verbindung der Formel (VII)



(VII)

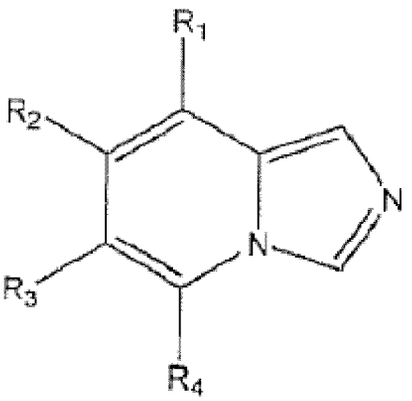
wobei R^2, R^3 und R^4 wie in Anspruch 1 definiert sind und X einen Substituenten darstellt, der für die Mitwirkung an einer Kreuzkupplungsreaktion geeignet ist,
mit einer Verbindung der Formel (VIII)

$$R^1\text{-}Y \qquad \text{(VIII)}$$

wobei R^1 optional substituiertes -C_{6-12} Aryl oder -bizyklisches Heteroaryl darstellt und Y ein Bor- oder Zinnderivat darstellt.

Revendications

1. Composé de formule (I)



(I)

ou sel ou solvate pharmaceutiquement acceptable de celui-ci, comprenant tous les tautomères et stéréo-isomères de ceux-ci, dans laquelle
R^1 représente un groupe alkyle en C_2 à C_8, alcényle en C_2 à C_8, - (alkyle en C_1 à C_6) -aryle en C_6 à C_{12} ; (alkyle en C_1 à C_6)-hétéroaryle bicyclique ; -aryle en C_6 à C_{12} ; ou hétéroaryle bicyclique ;

dans laquelle ledit groupe aryle en C_6 à C_{12} ou hétéroaryle bicyclique peut être éventuellement substitué par un ou plusieurs substituants choisis parmi un atome d'halogène, un groupe alkyle en C_1 à C_4, fluoroalkyle en C_1 à C_4, alcoxy en C_1 à C_4, fluoroalcoxy en C_1 à C_4, hydroxy, -SO_2 (alkyle en C_1 à C_4), - SO_2N (alkyle en C_1 à C_4) (alkyle en C_1 à C_4), -SO-alkyle en C_1 à C_4, -SO-cycloalkyle en C_3 à C_6, -C(O)O(alkyle en C_1 à C_4), benzyloxy et phényle ;
R^2 représente H ;
R^3 représente H ; et
R^4 représente H ;
dans laquelle le groupe hétéroaryle bicyclique désigne un résidu aryle en C_6 à C_{12} bicyclique dans lequel un ou plusieurs atomes cycliques sont remplacés par des hétéroatomes choisis parmi N, S et O.

2. Composé selon la revendication 1, dans lequel R^1 représente un groupe alkyle en C_2 à C_8, - (alkyle en C_1 à C_6) -aryle en C_6 à C_{12}, hétéroaryle bicyclique ou aryle en C_6 à C_{12}.

3. Composé selon la revendication 1 ou la revendication 2, dans lequel R^1 représente un groupe (alkyle en C_1 à C_6) -aryle en C_6 à C_{12} dans lequel le groupe aryle en C_6 à C_{12} peut être éventuellement substitué.

4. Composé selon la revendication 1 ou la revendication 2, dans lequel R^1 représente un groupe aryle en C_6 à C_{12}, le groupe aryle en C_6 à C_{12} pouvant éventuellement être substitué.

5. Composé selon la revendication 4, dans lequel R^1 représente un groupe phényle éventuellement substitué.

6. Composé selon la revendication 1 tel que défini dans l'un quelconque des exemples 1 à 27 :

(1) 8-butyl*H*-imidazol[1,5-a]pyridine,
(2) 8-benzyl*H*-imidazol[1,5-a]pyridine,
(3) 8-isobutyl*H*-imidazol[1,5-a]pyridine,
(4) 8-phényl*H*-imidazol[1,5-a]pyridine,
(5) 8-(2-fluorophényl)*H*-imidazol[1,5-a]pyridine,
(6) 8-(3-fluorophényl)*H*-imidazol[1,5-a]pyridine,
(7) 8-(4-fluorophényl)*H*-imidazol[1,5-a]pyridine,
(8) 8-(2-chlorophényl)*H*-imidazol[1,5-a]pyridine,
(9) 8-(3-chlorophényl)*H*-imidazol[1,5-a]pyridine,
(10) 8-(4-chlorophényl)*H*-imidazol[1,5-a]pyridine,
(11) 8-(2-(trifluorométhyl)phényl)*H*-imidazol[1,5-a]pyridine,
(12) 8-(2-méthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(13) 8-(3-méthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(14) 8-(4-méthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(15) 8-(2-(benzyloxy)phényl)*H*-imidazol[1,5-a]pyridine,
(16) 8-(3-(benzyloxy)phényl)*H*-imidazol[1,5-a]pyridine,
(17) 8-(4-(benzyloxy)phényl)*H*-imidazol[1,5-a]pyridine,
(18) 8-(biphén-2-yl)*H*-imidazol[1,5-a]pyridine,
(19) 8-(biphén-3-yl)*H*-imidazol[1,5-a]pyridine,
(20) 8-(biphén-4-yl)*H*-imidazol[1,5-a]pyridine,
(21) 8-(2-(trifluorométhoxy)phényl)*H*-imidazol[1,5-a]pyridine,
(22) 8-(4-(éthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(23) 8-(benzo[d][1,3]dioxo-6-yl)*H*-imidazol[1,5-a]pyridine,
(24) 8-(4-méthoxy-3-méthylphényl)*H*-imidazol[1,5-a]pyridine,
(25) 8-(2,3-dihydrobenzo-[b][1,4]dioxin-7-yl)*H*-imidazol[1,5-a]pyridine,
(26) 8-(3,4-diméthoxyphényl)*H*-imidazol[1,5-a]pyridine ou
(27) 8-(4-méthoxy-3,5-diméthylphényl)*H*-imidazol[1,5-a]pyridine

ou un sel ou solvate pharmaceutiquement acceptable de l'un quelconque de ceux-ci.

7. Composé selon la revendication 1 tel que défini dans l'un quelconque des exemples 1, 2, 3, 4, 6, 7, 9, 10, 12, 13, 14, 16, 19, 22, 25 ou 26 ;

(1) 8-butylH-imidazol[1,5-a]pyridine,
(2) 8-benzyl*H*-imidazol[1,5-a]pyridine,

(3) 8-isobutyl*H*-imidazol[1,5-a]pyridine,
(4) 8-phényl*H*-imidazol[1,5-a]pyridine,
(6) 8-(3-fluorophényl)*H*-imidazol[1,5-a]pyridine,
(7) 8-(4-fluorophényl)*H*-imidazol[1,5-a]pyridine,
(9) 8-(3-chlorophényl)*H*-imidazol[1,5-a]pyridine,
(10) 8-(4-chlorophényl)*H*-imidazol[1,5-a]pyridine,
(12) 8-(2-méthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(13) 8-(3-méthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(14) 8-(4-méthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(16) 8-(3-(benzyloxy)phényl)*H*-imidazol[1,5-a]pyridine,
(19) 8-(biphén-3-yl)*H*-imidazol[1,5-a]pyridine,
(22) 8-(4-(éthoxyphényl)*H*-imidazol[1,5-a]pyridine,
(25) 8-(2,3-dihydrobenzo-[b][1,4]dioxin-7-yl)H-imidazol[1,5-a]pyridine, ou
(26) 8-(3,4-diméthoxyphényl)*H*-imidazol [1,5- a] pyridine

ou un sel ou solvate pharmaceutiquement acceptable de l'un quelconque de ceux-ci.

8. Composé selon l'une quelconque des revendications 1 à 7, à utiliser comme médicament.

9. Composition pharmaceutique comprenant un composé selon l'une quelconque des revendications 1 à 7 éventuellement combiné à un ou plusieurs diluants ou véhicules pharmaceutiquement acceptables.

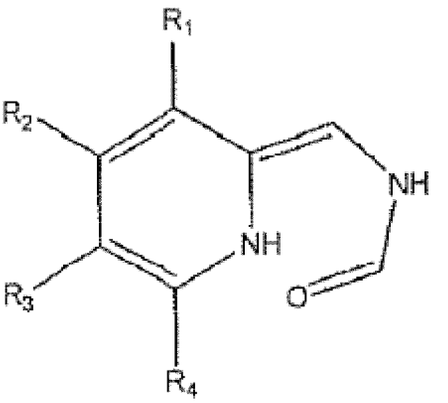
10. Composition pharmaceutique selon la revendication 9, qui comprend en outre au moins un agent thérapeutique supplémentaire.

11. Composé selon l'une quelconque des revendications 1 à 7, ou composition pharmaceutique selon la revendication 9 ou la revendication 10, à utiliser dans le traitement d'une maladie choisie dans le groupe comprenant la maladie de Kennedy, le cancer du duodénum avec ou sans infections à *Helicobacter pylori,* le cancer colorectal, le syndrome de Zolliger-Ellison, le cancer gastrique avec ou sans infections à *Helicobacter pylori,* les états psychotiques pathogènes, la schizophrénie, l'infertilité, la néoplasie, les réponses inflammatoires de l'hôte, le cancer, les métastases malignes, les mélanomes, le psoriasis, la sclérose en plaques, le syndrome de Guillain-Barré et la polyradiculonévrite démyélinisante inflammatoire chronique.

12. Composé selon l'une quelconque des revendications 1 à 7, ou composition pharmaceutique selon la revendication 9 ou 10 à utiliser dans le traitement d'une maladie choisie dans le groupe comprenant un déficit cognitif léger, la maladie d'Alzheimer, la démence familiale de type britannique, la démence familiale de type danois, la neurodégénérescence dans le syndrome de Down et la maladie de Huntington.

13. Composé selon l'une quelconque des revendications 1 à 7 ou composition pharmaceutique selon la revendication 9 ou 10 à utiliser dans le traitement d'une maladie choisie dans le groupe comprenant l'arthrite rhumatoïde, l'athérosclérose, la pancréatite et la resténose.

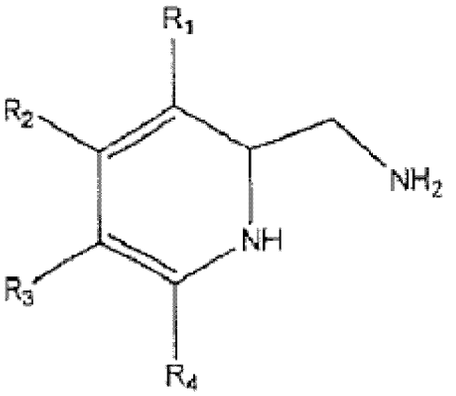
14. Procédé de préparation d'un composé de formule (I) selon l'une quelconque des revendications 1 à 7, qui comprend une réaction de fermeture de cycle d'un composé de formule (II)



(II)

ou dérivé protégé de celui-ci, dans laquelle R^1, R^2, R^3 et R^4 sont tels que définis dans l'une quelconque des revendications 1 à 7.

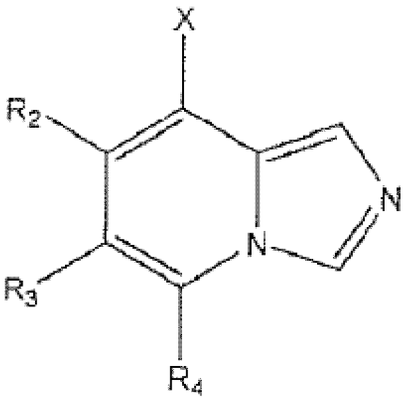
15. Procédé selon la revendication 14, dans lequel le composé de formule (II) est obtenu in situ par réaction d'un composé de formule (III)



(III)

ou dérivé protégé de celui-ci, dans laquelle R^1, R^2 R^3 et R^4 sont tels que définis dans l'une quelconque des revendications 1 à 7, avec un acide méthanoïque ou un dérivé activé de celui-ci.

16. Procédé de préparation d'un composé de formule (I) selon l'une quelconque des revendications 1, 2 et 4 à 7, dans lequel R^1 représente un groupe aryle en C_6 à C_{12} éventuellement substitué ou hétéroaryle bicyclique qui comprend une réaction de couplage croisé d'un composé de formule (VII)



(VII)

dans laquelle R^2, R^3 et R^4 sont tels que définis dans la revendication 1 et X représente un substituant qui est approprié pour participer à une réaction de couplage croisé
avec un composé de formule (VIII)

$$R^1\text{-}Y \qquad \text{(VIII)}$$

dans laquelle R^1 représente un groupe aryle en C_6 à C_{12} éventuellement substitué ou hétéroaryle bicyclique et Y représente un dérivé de bore ou d'étain.

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